

BULLETIN

OF THE

INTERNATIONAL RAILWAY CONGRESS

ASSOCIATION

(ENGLISH EDITION)

[728.33 (.493)]

The new engine shed at Schaerbeek-Formation,

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Figs. 1 to 16, pp. 1092 to 1120.

The Belgian State Railways Administration opened, a few months ago, a new engine shed at Schaerbeek-Formation Station. The construction of this shed was commenced before the war, but its completion was retarded in favour of other more important works.

Schaerbeek shed has been equipped with the principal modern improvements, and is especially designed to overcome as far as possible difficulties resulting from the lack and high cost of labour, and from the application of the eight-hours day. For this reason, large use is made of power appliances, and the object has been to reduce the time taken in all the operations which have to be carried out by the footplate staff, both when returning to the shed as well as when leaving it, so as to obtain their maximum utilisation during the eight-hour day. It is designed on the other hand to improve the conditions under which the staff have

to work. From this point of view, the building is very much improved in comparison with many of the older sheds. There is plenty of room, and it is well ventilated and lighted, while efficient means are provided for carrying off the smoke.

The *main building* measures 209 m. $\times$ 92 m. (685 1/2 feet $\times$ 302 feet); it consists of (fig. 1) two portions separated by the power sub-station and the machine shop and smiths' shop. Each portion contains nineteen pit roads, and when fully occupied will be able to accommodate 150 locomotives of the most powerful type. Pending such time as important extensions to the marshalling sidings are finished, one portion will not be used as a shed, but for the time being will be utilised as an engine repair shop and as a stores warehouse.

The building consists of a framework of reinforced concrete, the columns resting

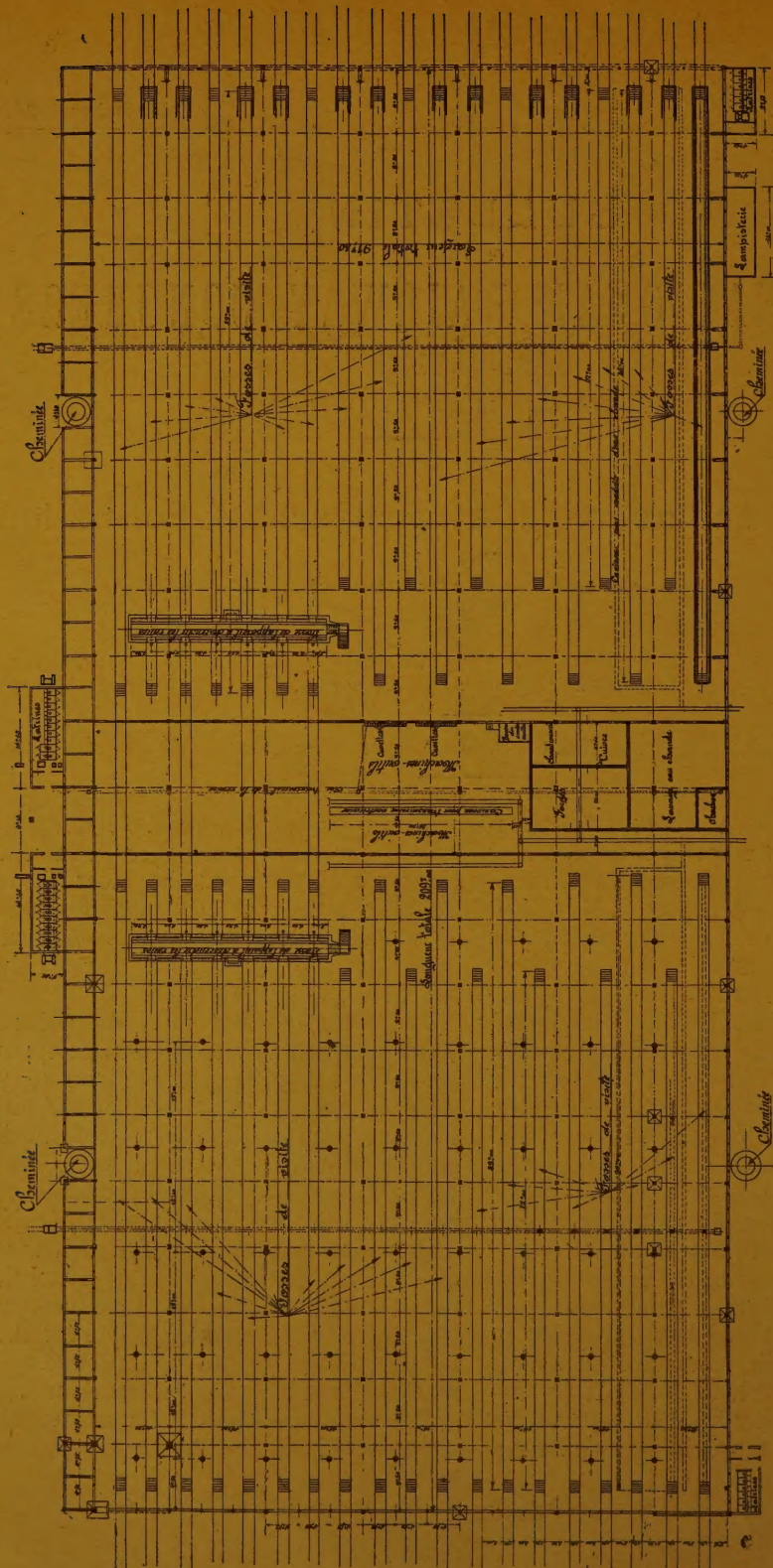


Fig. 1. — Schaarbeek-Formation Station. — Engine shed. — Plan.

Translation of French terms : Cheminée = Chimney. — Fosses de visite = Inspection pits. — Longueur totale = Total length : 685 1/2 feet. — Largeur totale = Total width : 302 feet. — Lampisterie = Lamp room. — Machines-outils = Machine tools. — Fosse de l'appareil à descendre les roues = Wheel drop. — Forges = Smiths' shop. — Chaudronnerie = Boiler smiths. — Cuivre = Coppersmiths. — Lavage eau chaude = Hot water washing out plant.

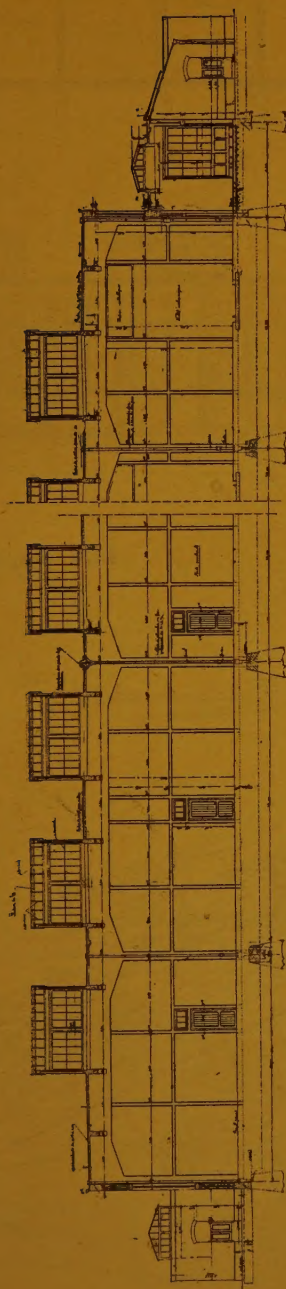
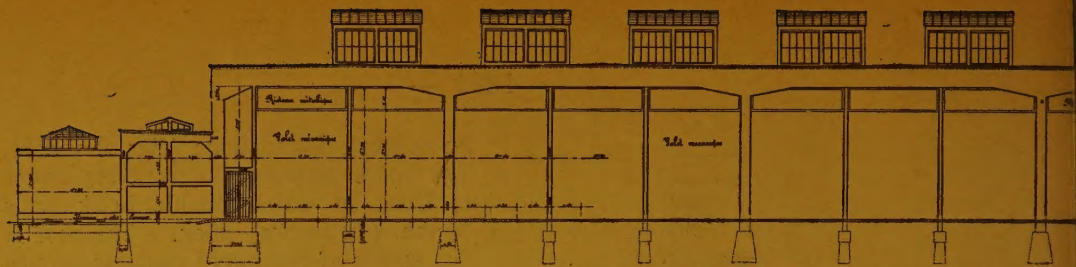


Fig. 2. — Schaebeck-Formation Station. — Engine shed. — Cross section.

on concrete foundations (figs. 2 and 3). The space between the concrete frame is filled in which double brick walls 30 cm. (12 inches) thick. The roof is flat and is of reinforced concrete carried on beams supported both by the columns of the side walls and also by rows of intermediate columns. A large number of sky lights and large windows in the front wall provide plenty of light for the interior of the building. The space between adjacent tracks, which is 3 m. $\times$ 3 m. 50 (9 ft. 10 in. $\times$ 11 ft. 6 in.) where the columns supporting the roof are concerned, allows the staff to pass between without risk of injury and to have plenty of room for work when making adjustments or light repairs. Inspection pits are provided throughout the whole length of the tracks, these being 1 m. wide and 1 m. deep.

At one side of each portion of the shed are six inspection pits provided with *wheel drops* 2 m. 30 (7 ft. 7 in.) wide and 3 m. 90 (12 ft. 10 in.) deep (fig. 6), which are constructed entirely of reinforced concrete. The equipment of each of these wheel drops consists of a carriage of the traverser type provided with two hydraulic jacks fixed on each side of the framework, the two pistons being connected together by a strong cross girder which carries the cylinder of a central hydraulic jack, the piston of which only has a stroke of 1 m. 09 (3 ft. 7 in.); the three hydraulic jacks being connected together by piping. The central piston is provided with a cradle for carrying the axle. Hydraulic pressure is provided by means of two pumps driven by a 5 H. P. motor, these pumping water which is carried in a reservoir on the truck. When the centre of the piston has reached the end of its stroke, the side pistons commence in their turn to rise and give the central jack an additional stroke of 1 610 mm.



Fig

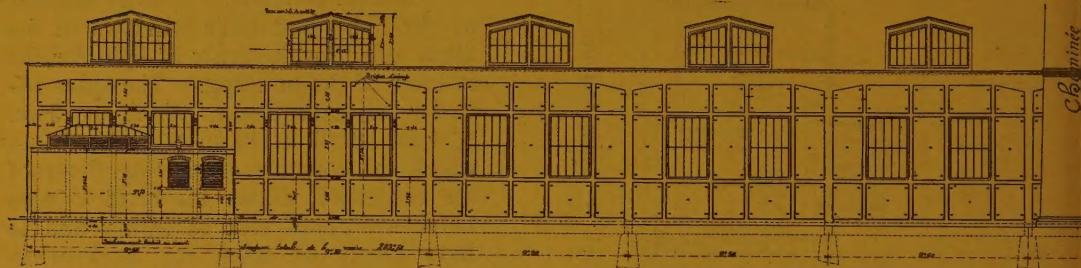


Fig. 4. — H

Figs. 3 and 4. — Schaarbeek

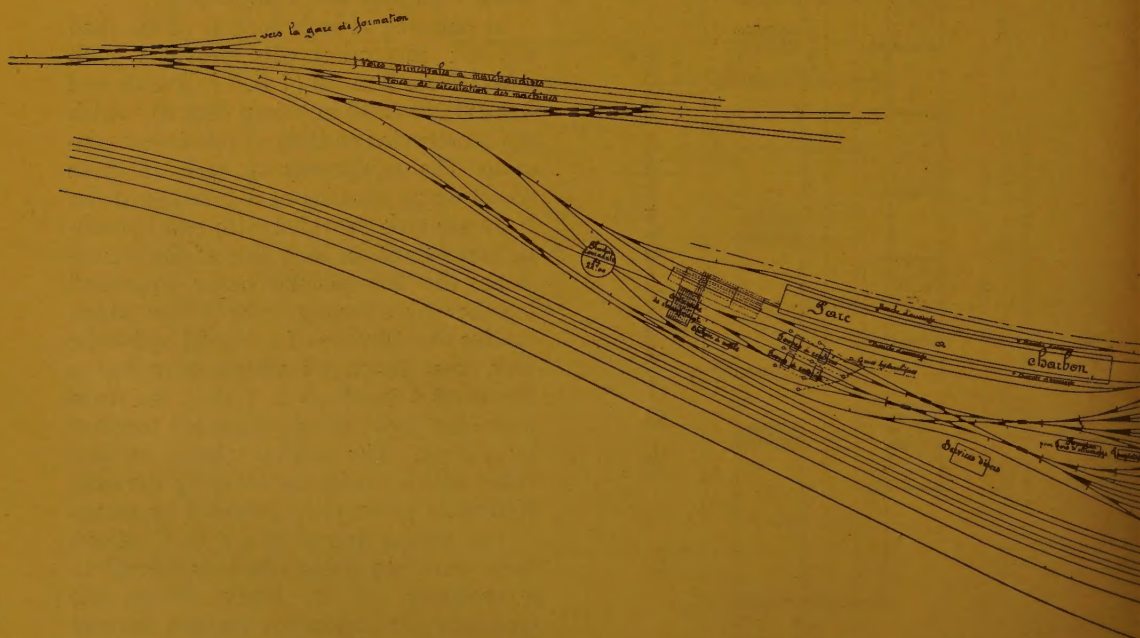
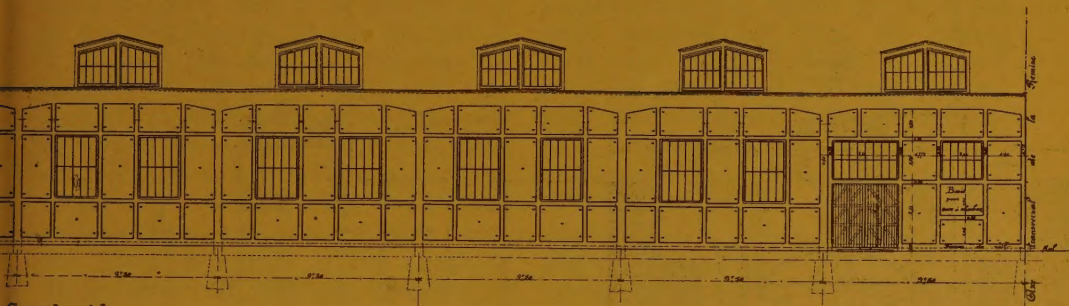


Fig. 5. — Schaarbeek-Fo

Translation of French terms : Limite des installations de la traction = Boundary of locomotive
Installation de mélange des charbons = Coal

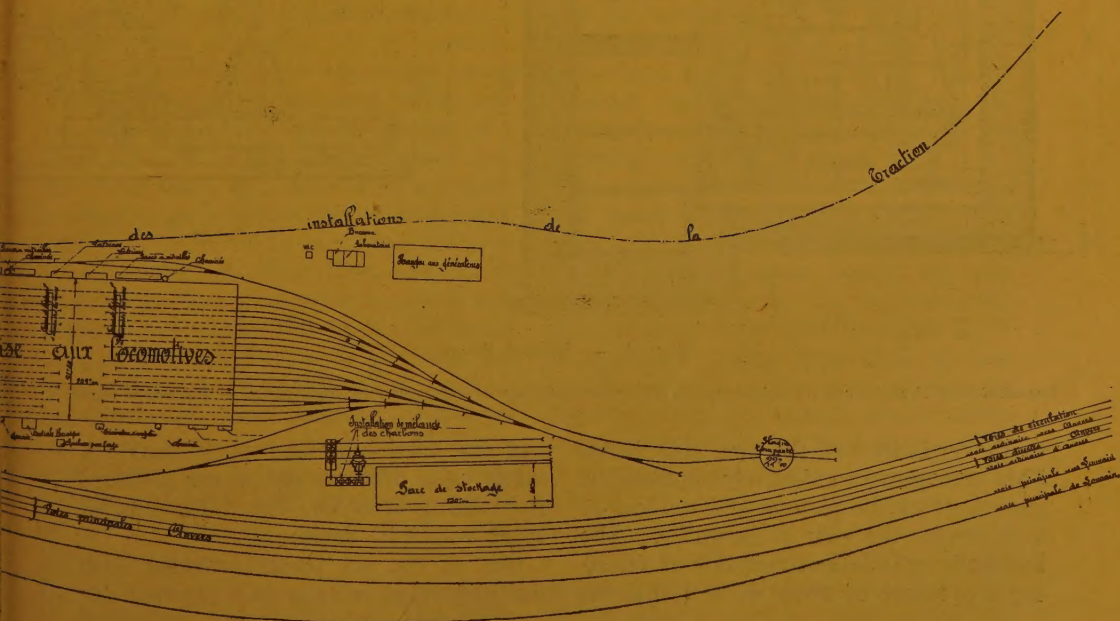


side.



South side.

tion Station engine shed.



tion. — General plan.

Remises — Remise aux locomotives. = Engine shed. — Parc de stockage = Coal storage dump.

— Plaque tournante = Turntable 72 ft. 2 in.

(5 ft. 3 3/8 in.), the total lift therefore being 2 m. 70 (8 ft. 10 5/16 in.). During the second phase of the lift, the entire

assembly consisting of the two side pistons and the cylinder of the central jack is controlled by two upright guides fixed

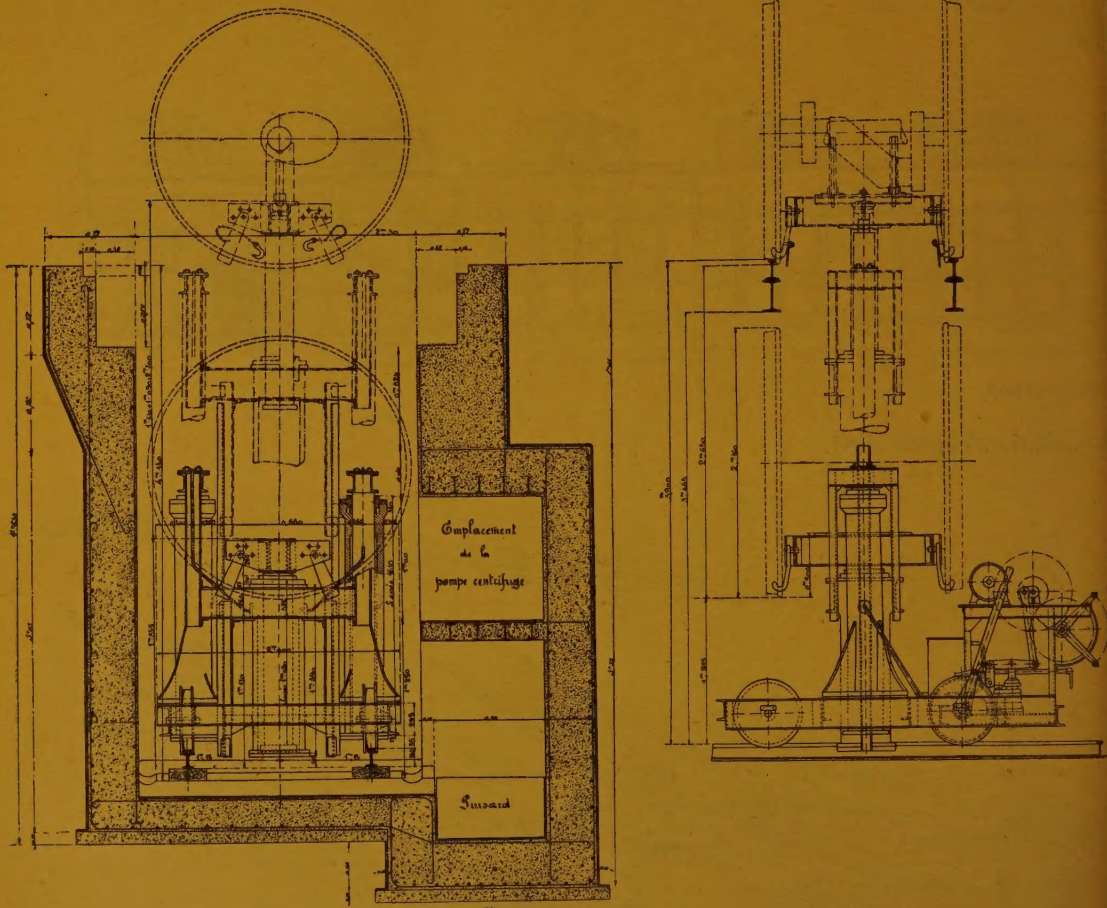


Fig. 6. — Wheel drop.

Translation of French terms : Emplacement de la pompe centrifuge = Space for centrifugal pump. — Puisard = Sump.

to the cylinders of the two side jacks. This arrangement effectively controls the movement of the pistons and reduces to a minimum the risk of jamming. The hydraulic cylinders are capable of resisting a pressure of about 60 atmospheres,

and the maximum load is 18 tons. A safety valve prevents the proper pressure from being exceeded. The lift is limited by an automatic device.

One of the six tracks provided with this apparatus is as a rule reserved for

removing pairs of wheels. The girders which carry the rails over the pit are mounted on rollers so that the rails can be moved laterally to a distance of about 670 mm. (2 ft. 2 3/8 in.) so as to allow the pair of wheels to be dropped. Normally therefore there is no discontinuity in the tracks served by the drop pit as is generally the case with the type of apparatus in which the jacks carry the portions of rail which support the pair of wheels. When the wheels have been dropped, the arrangement can move laterally under all the other tracks, and delivers the wheels on the outside track; the lateral movement of the apparatus being carried out by hand, by means of a lever and ratchet arrangement. After the necessary uncoupling has been done and the rails separated, the time taken to drop a pair of wheels is 2 minutes, the maximum time to traverse these to the end track is 10 minutes, while the time to lift these and place them on the road ready for removal is about 12 minutes.

The smoke is carried off by a system of flues provided with adjustable hoods which are normally open, and which may be closed from the ground by means of a lever operated by the driver (figs. 7 and 8). The flues, etc., consist of a framework of angle iron 50×50 mm. and 5 mm. (1.9 in.×1.9 in.×0.19 in.) thick, carrying plates of eternit. The flues and hoods are of a sufficient number to reduce to a minimum the space lost when it is necessary to accommodate, as is generally the case at Schaerbeek, engines of very different types and overall lengths. They communicate with four chimneys of 55 m. (180 feet) in height. These are constructed of brick and are provided with a spiral framework which allows their thickness to be reduced.

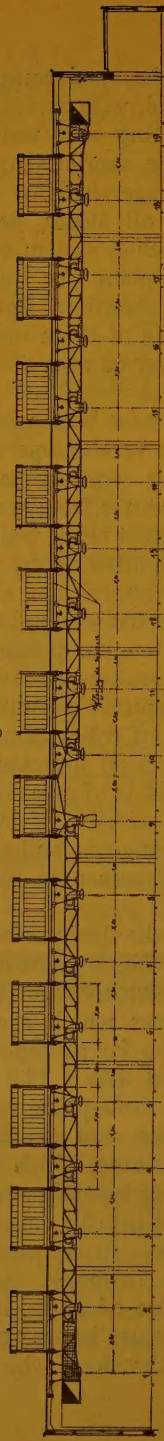
Additional equipment. — The addi-

tional equipment of the shed comprises the following: the yard, with arrival and departure tracks, coaling and watering plant, ashpits, turntable, sand drying furnace, lamp room, storage shed for wood used in lighting up, oil stores, general purposes building, Micheli system of hot water washing out, plant for mixing fuels, etc. The plan shown in figure 5 gives the general outlay of these installations, which extend over an area of about 11 ha. (27 acres).

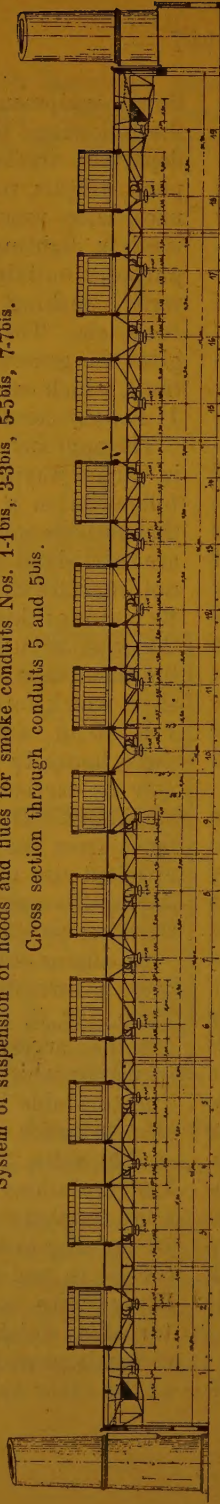
The approach roads have been arranged in such a way that the various operations follow on in a proper sequence and so that arrivals and departures from the shed are carried out by distinct roads which do not interfere with each other at any point. By means of this arrangement, and also by the extended use of mechanical appliances, the time taken for an engine to enter the shed, which formerly took as a minimum 1 h. 40 m., and sometimes as much as three hours in times of congestion, may now be carried out in 50 minutes at a maximum. This result is of great importance from the point of view of making efficient use of the engines and in reducing the number of men necessary for relieving purposes.

An engine entering the shed passes first over a turntable having a diameter of 22 m. (72 ft. 2 in.), which is sufficient for the largest engines which are now in use or which are so far contemplated. The turntable is fitted with a 12.5 H. P. electric motor taking three-phase current at 220 volts, 25 cycles, and running at 720 revolutions per minute, which allows a ten coupled engine of type 36, weighing in running order 158 t. to be completely turned in one minute. In the case of a break down to this turntable, another turntable, which is also of 22 m. in diameter, is provided for use in emergencies at the other end of the shed, which can

System of suspension of hoods and flues for smoke conduits Nos. 2-2bis, 4-4bis, 6-6bis, 8-8bis.
Cross section through conduits 2 and 2bis.



System of suspension of hoods and flues for smoke conduits Nos. 1-1bis, 3-3bis, 5-5bis, 7-7bis.
Cross section through conduits 5 and 5bis.



N. B. — For conduits Nos. 5-5bis, a channel iron $90 \times 69 \times 12$ (3 9/16 $\times$ 2 23/32 $\times$ 15/32 inches) to be fixed at the side of the roof lights for carrying the pulleys.

Cross section through the shed on the side nearest Brussels.

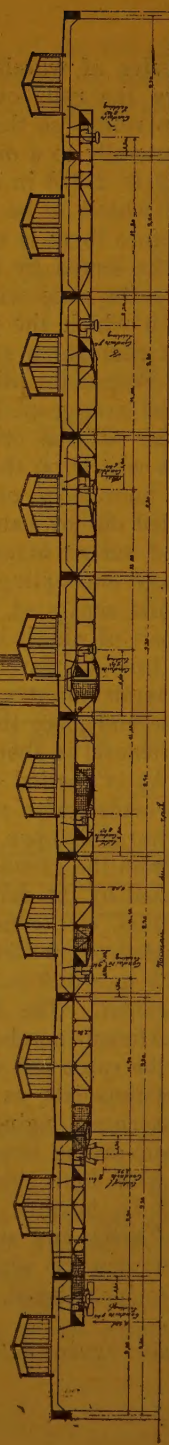
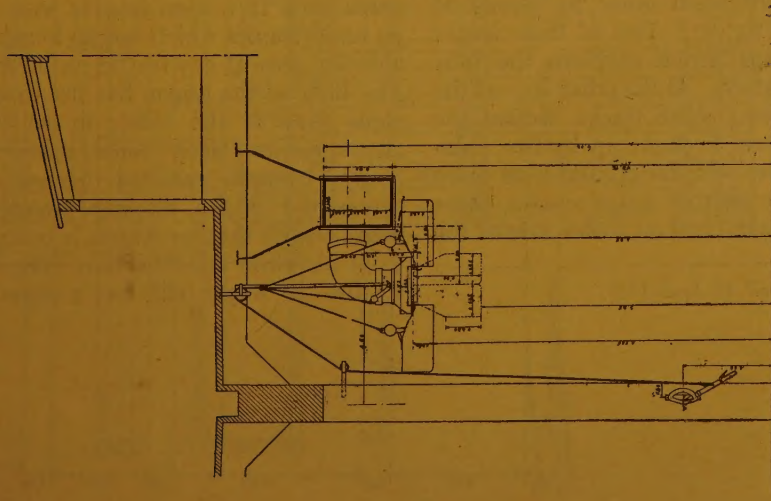
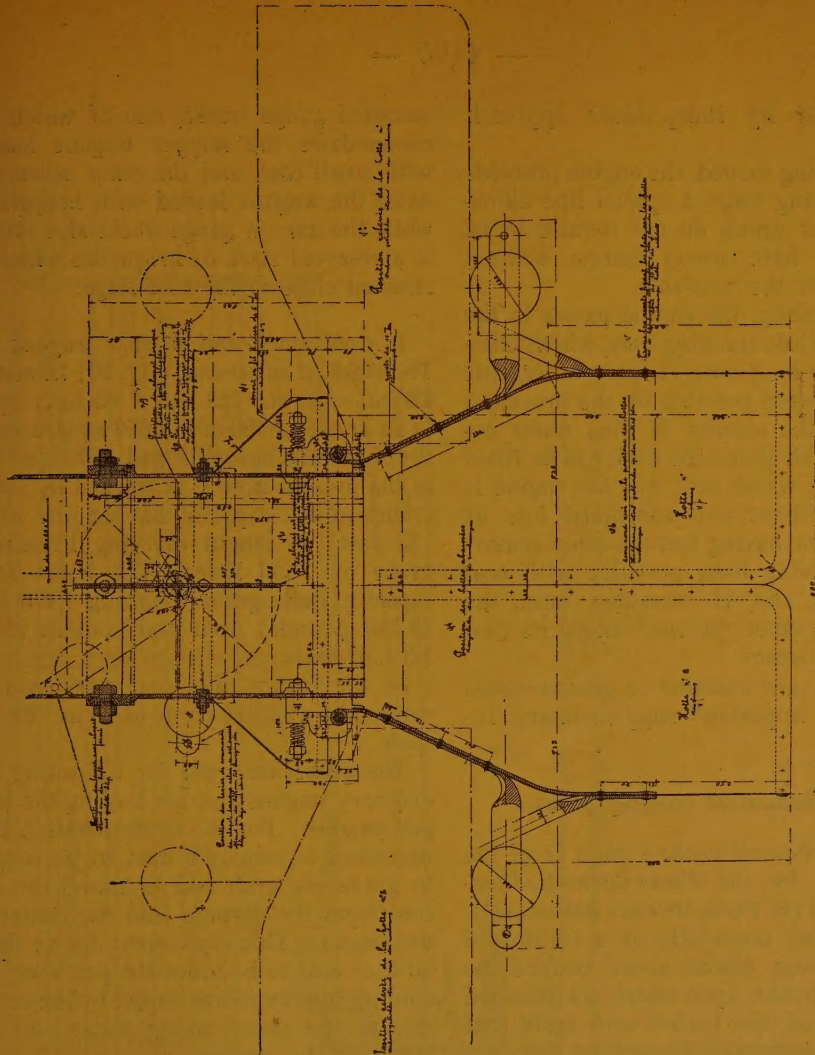


Fig. 7. — Schaerbeek-Formation Station. — Engine shed.
Arrangements for removing smoke from locomotives and forges. — Sectional views.



Arrangement of the operating gear.



Details of hoods.

Fig. 8. — Schaebeek-Formation Station. — Engine shed. — Arrangement for removing smoke from locomotives and forges.

be reached by independent approach roads.

After being turned, the engine proceeds to the coaling stage, a special line allowing engines which do not require to be turned to have access thereto without passing over the turntable.

After coaling, the engine passes to the ashpit. While standing here, which takes a relatively long time, it takes water, this being rendered possible by the provision alongside the ashpits of nine water columns, which allows the tender to be filled with water, which ever way the engine is turned, without any additional loss of time. Thus, having had the ashes removed and having been provided with coal and water, and, if necessary, sand, the engine can enter the shed under its own remaining steam.

We will now examine in greater detail the more important supplementary installations.

a) Mechanical coaling plant.

The *mechanical coaling plant* is of the type used by the *Paris-Lyons-Mediterranean and the Paris-Orleans Railways*⁽¹⁾

It consists essentially of a reinforced concrete stage placed above two of the incoming tracks, upon which are provided a number of tubs loaded with small coal or with briquettes. These tubs run on a series of narrow gauge tracks which communicate with each other by means of turntables (fig. 9). Two of these tracks serve the tips which overturn the tubs over the tenders. At the other side of the coal stage two other tracks receive the tubs which are brought up by two independent lifts. On the ground level there is a further narrow gauge system, these lines being arranged on either side of the

standard gauge tracks, one of which accommodates the hopper wagons loaded with small coal, and the other accommodates the wagons loaded with briquettes, while the narrow gauge tracks also extend to a reserved stack of briquettes which is situated close to the coal stage.

1. Coal stack and hopper wagons. —

The stack of small coal (fig. 10) measures 220 m. × 20 m. (722 feet × 66 feet) equal to an area of 4 400 m² (47 652 square feet), the side walls being formed of briquettes; at the present time it is worked by steam cranes of 5 t. capacity, having jibs 10 m. (33 feet) in length carrying Priestman grabs of 1 600 litres (57.5 cubic feet) capacity, these grabs weighing 1 470 kgr. (3 240 pounds) each and contain about 1.5 t. of coal.

In the future, this coal stack will be worked by a gantry crane of 20 m. (66 ft.) span.

The grabs are used for unloading the ordinary wagons and for loading the hopper wagons. For the first operation it is necessary to employ a man in the wagon to guide the grab and to shovel out the coal from the corners into the centre of the wagon. This equipment allows about 30 t. of coal to be unloaded per hour, including interruptions caused by the necessity of the crane taking water and for shunting the wagons.

The 20 hopper wagons used have been made from 12 t. open wagons with wooden underframes which are no longer suitable for present day traffic requirements. The floor of the wagon has been made to slope towards the sides, in which are fitted vertical drop doors operated by levers. Small inclined planes fixed across the wagon sloping towards the doors ensure that the wagon is completely emptied, while the sides have been raised so that the wagon still has a capacity of

⁽¹⁾ *Génie Civil*, 22 April 1916.

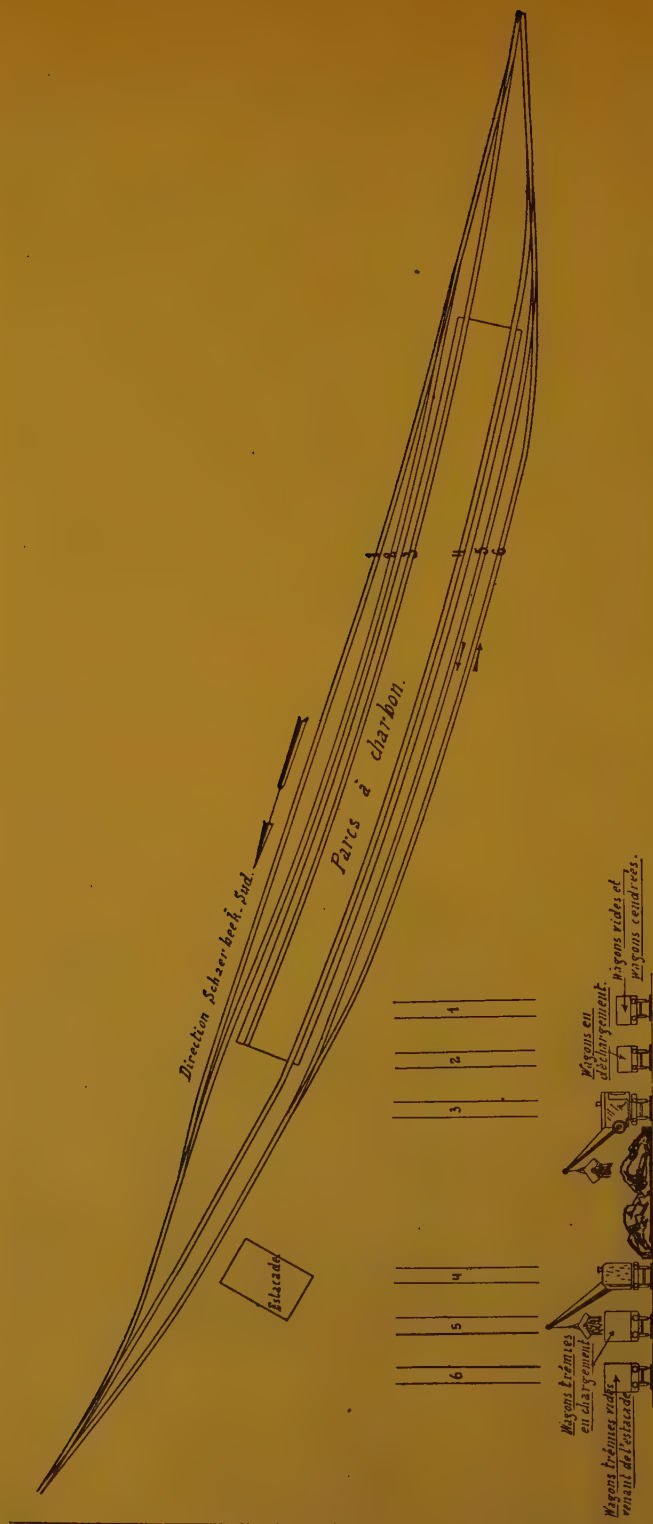


Fig. 10. — Arrangement of sidings at coal storage stacks.

Track 1. Loaded wagons and empty wagons from No. 2 track.

— 2. Loaded wagons.

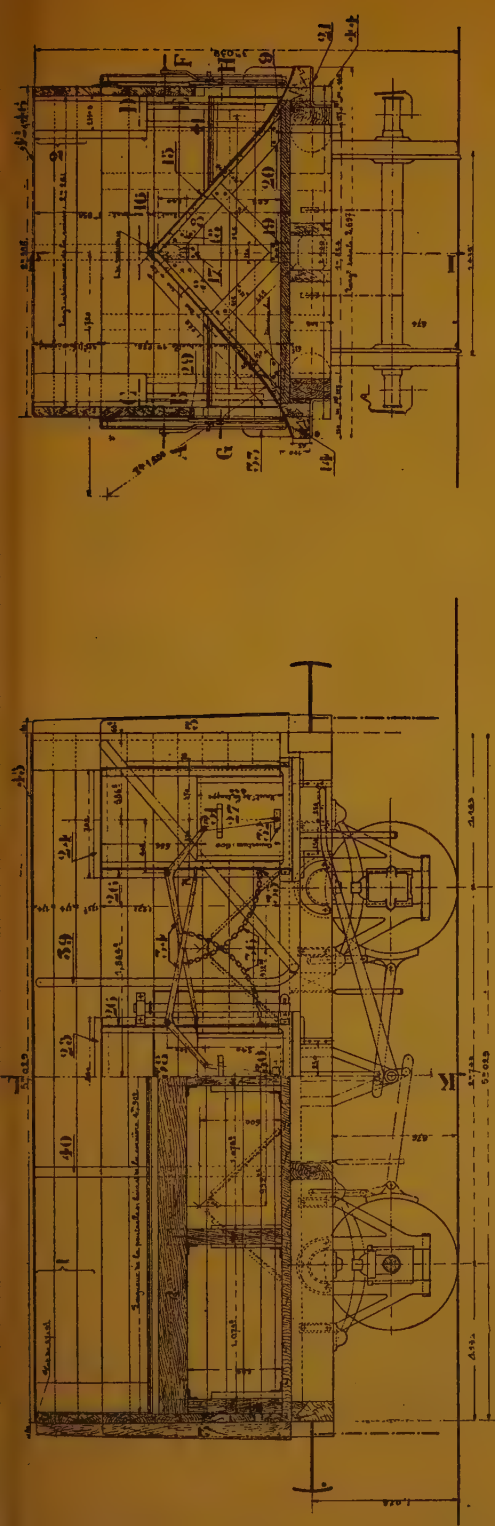
— 3. Crane for unloading.

— 4. Crane for unloading hopper wagons and through road for briquette wagons to the coal stage.

— 5. Hopper wagons loaded and in process of loading.

— 6. Empty hopper wagons coming from coal stage.

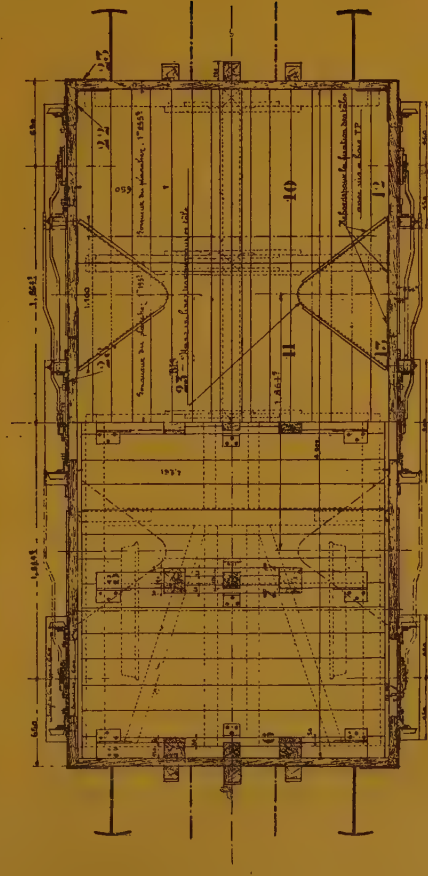
Translation of French terms : Parcs à charbon = Coal stacks. — Estacade = Staging. — Direction Schaarbeek-Sud = To South Schaarbeek. — Wagons trémiés en chargement = Hopper wagons being loaded. — Wagons trémiés vides venant de l'estacade = Empty hopper wagons coming from coal stage. — Wagons en déchargement = Wagons being unloaded. — Wagons vides et wagons cendrés = Empty wagons and wagons containing ashes.



Half section on line I-J.

Half elevation.

Cross section on line K-L.



Half sectional plan on line G-H. Half sectional plan A B C D E F.

Fig. 44. — Conversion of a 12 t. open wagon into a hopper wagon. — Capacity after conversion : 508 cubic feet.

12 t. (fig. 11). The output of the grab for loading these hopper wagons is about 30 t. per hour.

The total capacity of these hopper wagons (240 t.) corresponds to the daily coal consumption; this number is sufficient where the coal stack is close to the stage.

Pending the construction of the central depot for mixing coal, which will be dealt with later on, coal is mixed in a rough and ready way by selecting the wagons to be unloaded in groups in accordance with the various sources of supply, which when mixed produce a fuel having a suitable percentage of volatile matter and cinders. The wagons in each group are unloaded on to the same heap, while when the coal is picked up by the grab which digs some distance into the heap, it completes to a certain extent the mixture in the same way as does the tipping of the coal into the tubs when the doors of the hopper wagons are opened, this being done more or less depending on the height of the wagon.

The coal stack is worked in the following manner: One half of the length of the stack is replenished by means of a steam crane running on track 3, while the other half is taken from by a second steam crane on track 4 for loading up the hopper wagons. Periodically tracks 2 and 3 are used instead of 4 and 5, and conversely. If large consignments of coal are coming in, one half of the stack may be made up before the other half is cleared away, and one then commences to take from the half which is being filled up by taking coal from the oldest heaps, care being taken to use in the first place the coal remaining in the other half when the change over is again made. Track 1 is used for empty wagons, and track 6 for hopper wagons, empty or otherwise.

2. *Lifts and coal tubs.* — The loaded

hopper wagons are taken to a siding close to the coal stage, and the coal tubs are filled by opening the doors in the sides of the former. These may be weighed on a small weighing machine of 1 000 kgr. (2 200 lb.) capacity which is provided close to the lifts, but this is only occasionally done as a check. The narrow gauge tracks are laid with a falling gradient of 1 in 500 to 1 in 333 towards the lifts so as to facilitate the handling of the loaded coal tubs.

The coal tubs, which are 150 in number, have a capacity of 550 dm³ (19.4 cubic feet), so as to hold 500 kgr. (1 100 lb.) of small coal or briquettes.

Figure 9 shows the lay-out of the narrow gauge tracks, which is such as to assure free circulation of the loaded and empty coal tubs in a continuous direction, the loaded tubs being placed on one side of the lift, and the empty tubs are pushed on the other side of the lift, from whence they are taken away on their own specially provided tracks.

Each lift accommodates one tub at a time. The lifting gear, which is accommodated at the top of the structure in a closed cabin, is operated by a three-phase electric motor of 6.5 H. P. making 750 revolutions per minute. The speed at which the lift works is 50 cm. (19.7 inches) per second. An adjustable counter-weight of cast iron balances the weight of the cage and of one half of the load. An automatic device records the number of tubs lifted.

The hourly capacity of each lift may be as much as 50 loaded tubs, that is to say, 25 t. of fuel provided that empty wagons are sent down and full wagons are sent up successively without interruption.

3. *Coal stage and tips.* — The level of the coal stage platform is 5.60 m. (18 ft. 5 in.) above rail level, and its area is $16 \times 24 = 384 \text{ m}^2$ (52 ft. 5 in. $\times$ 78 ft.

8 in. = 4 133.5 square feet). It is provided with nine narrow gauge tracks which serve the tips, these being connected with three transverse tracks by means of a number of turntables. This arrangement assures unrestricted circulation of the coal tubs on the coal stage at busy periods, and at such time one may make use of portions of track marked with a double pointed arrow on figure 9 for the accommodation of empty tubs which cannot be returned to ground level sufficiently quickly. These tracks may also be used to receive loaded tubs at quieter periods, which allows a reserve of 100 tubs or 50 t. of coal to be kept in hand.

Each tip is capable of dealing with about 90 coal tubs, or 45 t. of fuel per hour. A hopper with a 0 m. 40 × 1 m. 25 (1 ft. 3 in. × 4 ft. 1 in.) opening, which is provided below the tip, guides the fuel as it falls, and facilitates the coaling of the narrow bunkers on tank engines. The width of 0 m. 40 (1 ft. 3 in.) being the minimum dimension which does not cause any obstruction to the flow in the case of briquettes.

4. *Output of the plant.* — In order to describe the conditions under which the plant operates, one may, by means of statistics which have been kept over a certain period, obtain the average quantity of fuel placed on the tenders hour by hour. Let us draw the curve OPQA representing the sum of these averages starting from a certain hour which is taken as the origin, say for instance, 8 o'clock in the morning. In order to be certain of being able to handle the average total daily output BA (= 333 t.), it is necessary to feed the coal stage by means of a lift which gives as a minimum a constant hourly output of $\frac{BA}{24} = \frac{333}{24} = 13.9$ t., or in round figures

14 t.; the output of the lift being represented by the angle made by the straight line OA with the axis of X.

If we draw from the curve OPQA the external tangents O'P A' and O'' QA'', the quantity represented by $q'Q = 35$ t. represents the minimum quantity of coal which it is necessary to hold in reserve on the coal stage to meet the varying demands of the tips, the lifts working at a constant output of 14 t. per hour. At P (10 o'clock in the morning) the full reserve will be in hand, while at Q. (midnight) the reserve will have entirely disappeared. In practice, the maximum reserve which one can accommodate on the coal stage is, as we have seen, 50 t., and by drawing O''' A''' parallel to O' A' at a distance therefrom equal to A' A''' = 50 t., the vertical distances included between the curve OPQA and the straight line O''' A''' give at any instant the amount of reserve which will be in hand on the coal stage.

In practice, the rate at which freight engines return to the shed varies widely from one day to another, the shape of the curve OPQA therefore varies considerably, but it has been found at Schaerbeek that it as a rule lies between the straight lines O' A' and O''' A'', so that it may be said that the constant output of 14 t. per hour for one lift would be sufficient for the present day output of the plant. If the curve OPQA tended to rise above the area (O' O''' A''' A'), the situation would be met by increasing the output of the lifts during convenient periods, as these lifts, as we have seen, can handle an hourly output of 25 t.; or else, if need arose, one might use the spare lift.

This investigation allows us to determine the maximum strength of the gang of labourers for operating the plant.

However, in practice, in order to make efficient use of these men and to reduce the loss due to slack periods, it is an advantage to vary the composition of the gang of the ground level and of those on the coal stage in order that as far as pos-

sible a reserve may be built up on the same during the periods when only a small amount of coal is being loaded on to the tenders, so that at many times one man is all that is necessary on the coal stage, while the gang unloading in the

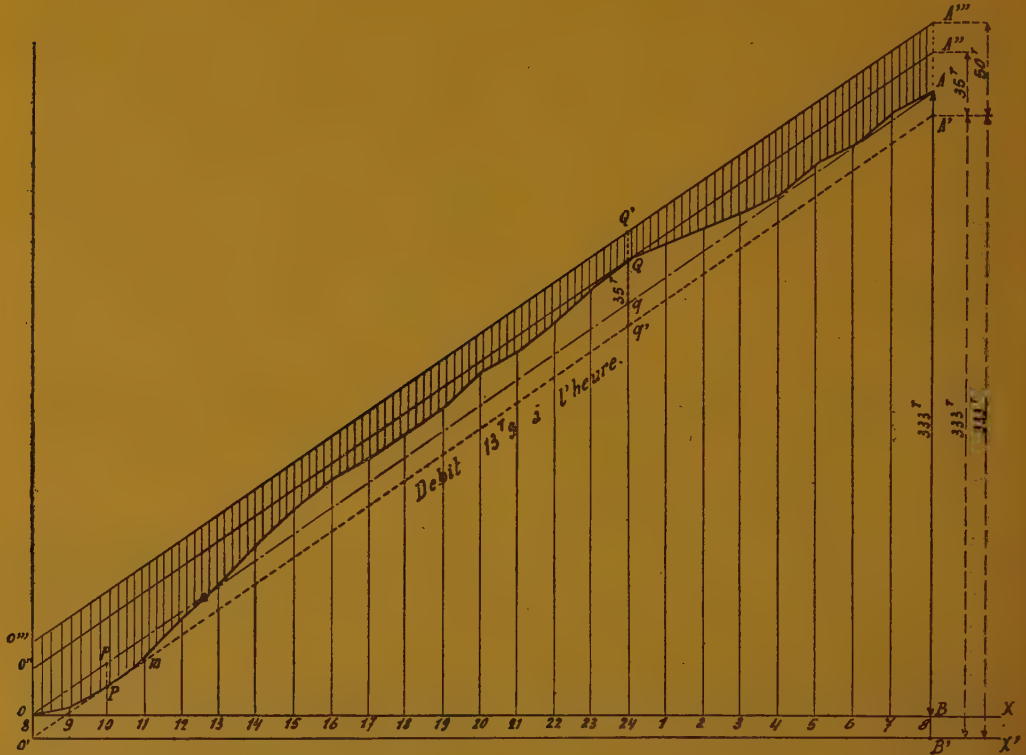


Fig. 12. — Diagram showing output (coal stage).

Translation of French terms : Débit 13.9 à l'heure = Output 13.9 per hour.

yard is strengthened by the men off the coal stage, and *vice versa*. The output of the lifts is therefore represented by a broken line consisting of portions which are horizontal, or more or less inclined to be horizontal. The portions of this broken line approaching nearest to the horizontal corresponding to points at

which the curve OPQA has its maximum inclination, and *vice versa*.

The line O'''A''' is therefore a broken line at a distance O'O''' = 50 t. from the broken line O'A'; these two lines vary widely from day to day according to the way in which engines enter the shed, and therefore to arrive at an efficient output,

the work of the men employed on the coal stage should be regulated by practical experience.

Maximum output. — The number of engines to be coaled daily at Schaerbeek is about 95; the average amount of coal put on each locomotive is therefore $\frac{333}{95} = 3.6$ t., say 4 t. The busiest periods are as a rule about 10 engines per half hour, corresponding therefore to an output of 80 t. per hour which can be handled without difficulty by the two tips working simultaneously. The plant is therefore capable of dealing with maximum requirements, and although only a few engines can be coaled simultaneously, no serious delay is experienced, as the time taken is in all cases very short, the coaling of an engine taking on the average about six minutes.

If t_1 is the number of hours during which the maximum output may be maintained without interruption, and supposing one commences with a maximum reserve of 50 t. on the coal stage and that sufficient labour is available to operate the two lifts at their full output (50 t.), it will be seen that :

$$50 \text{ t.} + t_1 \times 50 \text{ t.} = t_1 \times 90 \text{ t.};$$

which gives $t_1 = 1 \frac{1}{4}$ hours corresponding to the coaling of $\frac{112}{4} = 28$ locomotives.

The plant is therefore capable of maintaining for one and a quarter hours an output equal to more than six times the average present output, and can maintain a constant output equal to $\frac{50}{14} = 3 \frac{1}{2}$ times the average output.

5. *Cost of labour for operating the coaling plant.* — The timing of the different operations connected with the

handling of the fuel allows one to estimate the total amount of labour necessary per working day, leaving a sufficient margin for loss of time due to passing from the coal stage to the ground level, and *vice versa*, and leads to the conclusion that if the operations are properly controlled in order to maintain a reserve upon the coal stage, the number of men required should not be more than five, including the man in charge, that is to say, 15 men for complete 24 hours. The man in charge should always supervise as far as possible the work on the coal stage itself.

Under these conditions, the cost of handling a ton of coal from the time it leaves the hopper wagons in the case of small coal, or from ordinary wagons in the case of briquettes, is 0 fr. 75 per tonne, this including wages, cost of power, maintenance, interest and depreciation.

The unloading of wagons of small coal by means of the grab costs 0 fr. 60 per tonne inclusive; the loading of the hopper wagons by means of the grab costs 0 fr. 50. The complete cost of handling a tonne of small coal is therefore 1 fr. 85. Formerly this was 1 fr. 20 + 1 fr. 45 = 2 fr. 65 with the old method (unloading with a shovel and loading into tubs that were lifted by means of fixed electric cranes). The economy is still more important in the case of briquettes, which formerly cost 1 fr. 30 + 1 fr. 45 = 2 fr. 75 per tonne. However, one must also consider the indirect economy resulting from the rapidity of loading. In the old shed, the average time taken for coaling was seven minutes per tonne, while every minute that an engine is standing costs, at the present time, in wages and fuel, about 0 fr. 10. The economy realised with the new as compared with the old method from this point of view is therefore 0 fr. 70 — 0 fr. 15 = 0 fr. 55 per tonne.

Moreover, at busy periods, engines were kept standing a long time waiting to get to the coal stage, and this feature, which is particularly undesirable as regards the regularity of the service, has completely disappeared since the new coal stage has been built. A plant such as this forms, moreover, a good solution of the problem which arises at sheds which burn coal and briquettes, and if there are certain methods of handling fuel which are better from the point of view of loss of labour such as overhead cranes of modern design, or coal stages supplied by chain conveyors, these are not as a rule a satisfactory method of coaling with briquettes. These, however, in the majority of our sheds are of sufficient importance to receive a special consideration. If, on the other hand, one should adopt both chain conveyors for the small coal, and stages for the briquettes, the cost of labour might be reduced still more, but the first cost of the installation might considerably increase the cost when dealing with the moderate outputs handled at our sheds.

The adoption of the coal stage of the kind to which we have just described is especially justified, by the necessity of finding a method of rapid coaling, which is not excessive as regards first cost and which requires less labour as compared with the methods which were formerly used.

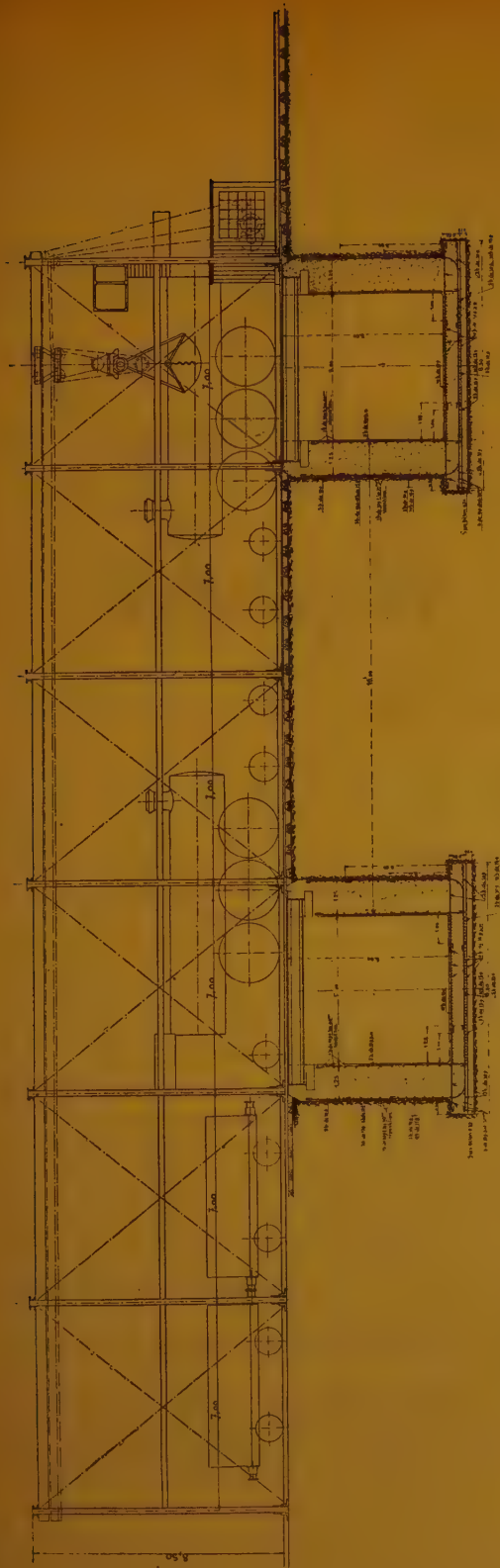
b) Arrangement for dealing with ashes.

This consists of four large ashpits with sloping sides arranged in two groups side by side, the two pits of each group being 16 m. (52 ft. 5 in.) apart. In this way eight engines of the largest types can be dealt with simultaneously whichever way they may be turned.

The pits (fig. 13) are 9 m. wide $\times$ 5 m.

long (29 ft. 6 in. $\times$ 16 ft. 4 in.) at the ground level, each of these being spanned by steel girders carrying the rails supporting the locomotives. A grating which has a width 1 m. (3 ft. 3 in.) greater than the distance between the rails, allows one to walk over the pit. Jets of water fed from the main water supply allow the ashes to be slaked. In view of the unstable nature of the sub-soil, the pits have been constructed entirely in reinforced concrete.

Each pair of pits is provided with a metal structure which is erected between the tracks occupied by the engines, this structure carrying an overhead crane provided with a grab (fig. 13). The gear for operating the grab and for traversing the overhead crane are accommodated in a hut with glass windows situated on the ground level. The controls of the electric motors and other gear operating the apparatus being so situated that the crane-man is kept in full view of all the movements of the grab; this is of the two-cable type and has a capacity of 1 m³ (35.3 cubic feet) and therefore holds about 800 kgr. (1 760 lb.) of ashes. It is operated by a special winch which is provided with two cable drums, one for the principal lifting drum being provided for the cable used for closing and lifting the grab when it is filled, while the other is provided with the auxiliary cable leading to the grab for opening the same and for holding it open when being lowered on to the ashes. The auxiliary drum is driven from the main lifting drum by a friction clutch operated by a lever in such a way that the grab may be opened when it is at a suitable height above the wagons which are standing on the middle track, or at a suitable height above the pits. The opening or shutting of the grab depends on the relative displacement of the two cables caused by holding the auxiliary drum at



Longitudinal section.

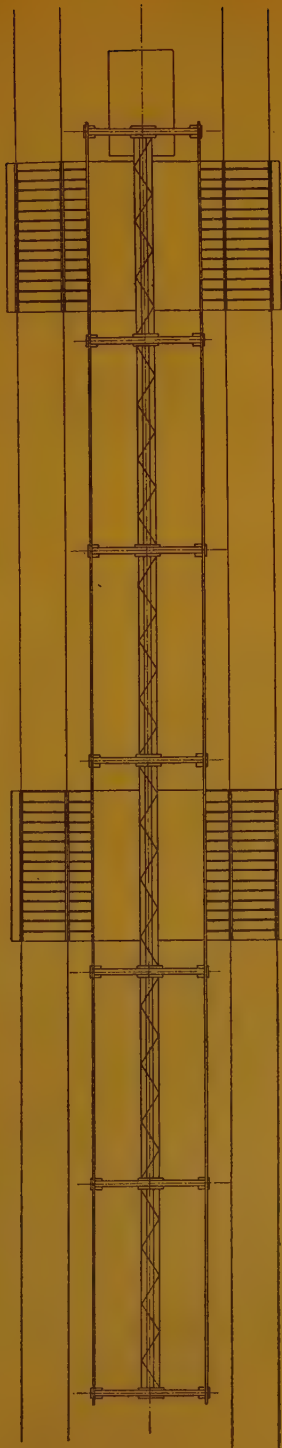
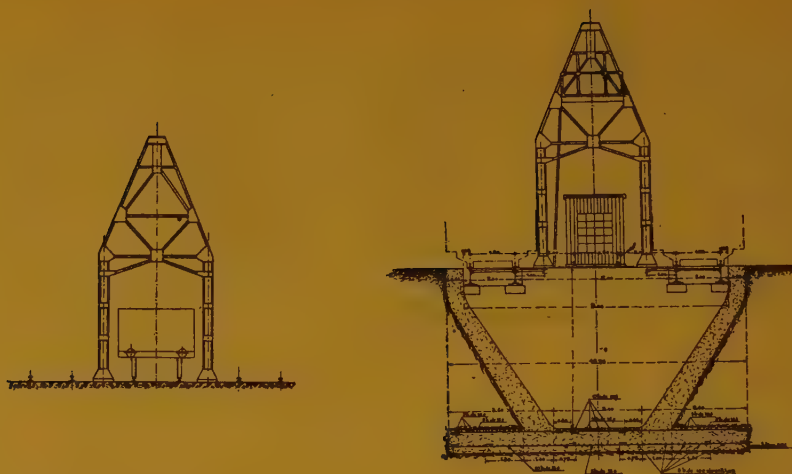


Fig. 13. — Schaerbeek-Formation Station. — Asb pits.



Cross section.

Fig. 13 (continued). — Schaerbeek-Formation Station. — Ash pits.

rest by means of the brake. When lifting or lowering the grab, on the other hand, the two drums revolve at the same angular velocity so that the cables have no relative movement.

The overhead carriage which carries the grab is operated by a special cable passing over two pulleys fixed at the two ends of the structure and which are connected with the drum of the traversing winch.

The winches are driven by asynchronous three-phase slip ring motors, one of 15 H. P. for lifting, and the other 7 1/2 H. P. for traversing. The lifting speed is 10 m. (32.8 feet) per minute, while the traversing speed of the carriage is 34 m. (111.5 feet) per minute.

Each of these two apparatus allow a wagon to be loaded with an average of 11 m³ (388.5 cubic feet) of ashes per hour, these being taken from one or other of the two pits. The daily output of ashes at the shed being on the average 70 t., that is $\frac{70}{0.8} = 88 \text{ m}^3$ (3 108 cubic

feet), the two groups of pits can be cleared in a single shift of eight hours. The cost of operation, including (wages, electric current, interest and depreciation and repairs of the mechanism) is 1 fr. 35 per tonne of ashes, of which interest and depreciation account for 0 fr. 82. It must, however, be borne in mind that the plant will be capable of meeting any increase in traffic, and it now allows the most busy periods to be dealt with without any delay being caused by engines waiting to pass on to the ashpits, and this, as in the case of the coaling plant, leads to considerable indirect economies and assures great regularity in the movements in the shed. The cost of moving ashes by hand at the present time is at least 1 fr. 75 per tonne.

c) Micheli hot water washing-out plant.

The plant for washing out and filling up boilers with hot water is of the type in which use is made of the heat con-

tained in the water emptied from boilers which have to be washed out. It is also provided with pumps which are automatically operated by means of hydro-electric apparatus (Micheli patents) which start or stop the pumps when the pressure in the washing-out plant varies from the set pressure.

The plant is represented diagrammatically by figure 14. In the pits set aside for washing out are laid three pipes, one being connected by a flexible pipe to the blow off cock on the boiler, the other carrying the washing-out water at a pressure of about eight atmospheres, while the third is used for filling the boilers with hot water after washing out. Before being washed out, a boiler contains, for example, 5 m³ (176 1/2 cubic feet) of hot water and 2 m³ (70.6 cubic feet) of steam at a pressure of 4 to 5 kgr. per cm² (57 to 71 lb. per square inch), that is to say, a temperature of about 145° C. (293° F.) This water is forced out by the steam pressure into the concrete reservoir *i* by way of an apparatus *b* in which it gives up its heat and through a filter *d*.

Reservoir *g* is for clean water for filling up the boiler; a pump *f* causes this to circulate through the filters *b* before it is admitted to reservoir *g*; it also passes through a coil pipe *e* located in the reservoir *i*. Automatic regulator *c* admits feed water in a quantity proportional to the amount which is being blown down from the boilers. It will thus be seen that there is a definite relation between the temperature of the water blown off (60° C. or 140° F.) which, after being filtered, is used for washing out, and of the clean feed water (80° C. or 176° F.).

Communication is provided between reservoirs *g* and *i*, which in case of necessity allows a temporary lack of

washing-out water to be made up. Moreover, live steam may be in some cases used to obtain the correct temperatures when the heat provided from the water blown off from the boilers is insufficient.

The apparatus at Schaerbeek is designed to carry out simultaneously, per eight hour day, the following operations:

a) to receive the water blown off from the boilers of twenty locomotives, the pressure at the time of blowing off being about 5 kgr. per cm² (71 lb. per square inch), and each locomotive containing about 6 m³ (212 cubic feet) of hot water and 2.5 m³ (88.3 cubic feet) of steam, and under these conditions the boilers are emptied in about forty minutes;

b) to wash out twenty boilers with hot water, the time taken for this operation being about forty minutes;

c) to refill the twenty boilers with hot water at 80° C. (176° F.), the time taken being about twenty minutes.

The total time therefore taken for the complete series of operations which have to be carried out with each engine is about two hours, and as a rule two engines are dealt with simultaneously.

The saving in coal which is effected by re-utilising the heat in the water from the boilers is considerable, and may be estimated as 2 1/2 to 3 t. per day.

As the plant is situated in close proximity to the laboratory in which fuel is tested at Schaerbeek, the steam produced by the boilers used for the vaporisation tests can also be utilised, and this steam serves to regularise and improve the temperature existing in the washing-out plant.

The operation of the washing-out plant only requires one attendant, and it may be therefore estimated that compared with the system of washing out by means of injectors or by pumps without any heat recovery appliances, it does not entail any

additional charges either for labour or upkeep, and the economy of fuel and water largely compensate the interest and depreciation on the first cost. On the other hand, the system allows a reduction to be made in the cost of the labour necessary for washing out, as this can be done rapidly and easily on account of the high pressure of the jet of water and of the suitable temperature of the washing-out water. Finally, one may mention the advantage as regards its convenience and also the reduction in the length of time engines are kept standing for washing out purposes.

d) Arrangements for mixing and storage of coal.

This plant, which is designed and constructed by Messrs Kainscop, is shown diagrammatically in figure 15, and consists of two separate parts :

1° A mixing plant, now in course of construction, which effects the following operations :

- a) unloading of wagons by tipping;
- b) placing coal of the different categories in hoppers;
- c) their mixing in the right proportion;
- d) conveying of the mixed coal to storage bunkers from which the engines are coaled, or loading the coal into wagons consigned to engine sheds in the Brussels, Malines and Antwerp districts, which are supplied from the Schaerbeek depot.

2° A storage dump, which will be shortly completed, consisting of :

- a) plant for unloading coal from various sources or coal which has been mixed;
- b) plant for picking up coal from va-

rious sources or coal which has been mixed.

1° *Coal mixing.* — The wagons are unloaded by means of a wagon tip (1) of the « Kainscop » type, which gives the wagon an inclination of about 45°.

The greater part of the contents of a wagon passes through the doors and falls into an underground hopper.

Two men then get into the wagon and rapidly complete its unloading.

The hopper for receiving the coal has in its lower part two openings, in each of which is a device for regulating the flow of coal and for delivering it into the buckets of the two elevators (2 and 3) each of which are capable of an hourly output of 60 t.

By means of two shoots, each of which are provided with a double by-pass, the coal from the elevator is delivered either on to two chain conveyors (4 and 5) which serve the four bunkers for the unmixed coal, or else on two conveyors (15 and 16) which feed the bunker from which the overhead runway feeding the storage dump is loaded (18). The two chain conveyors are each capable of conveying coal of different qualities to the bunkers at the rate of 60 t. per hour.

Each bunker for the unmixed coal has a capacity of 120 t., and has at the bottom a measuring device, the capacity of which can be regulated.

Belt conveyors (8 and 9) receive the coal from the four measuring devices, whose output can be regulated so as to mix the coal of different qualities in the required proportions, in order to obtain a fuel which meets the requirements of the running department.

One of these belt conveyors (8) takes the coal to the foot of an elevator (11), of the type described above, which lifts the mixed coal and delivers it on to a

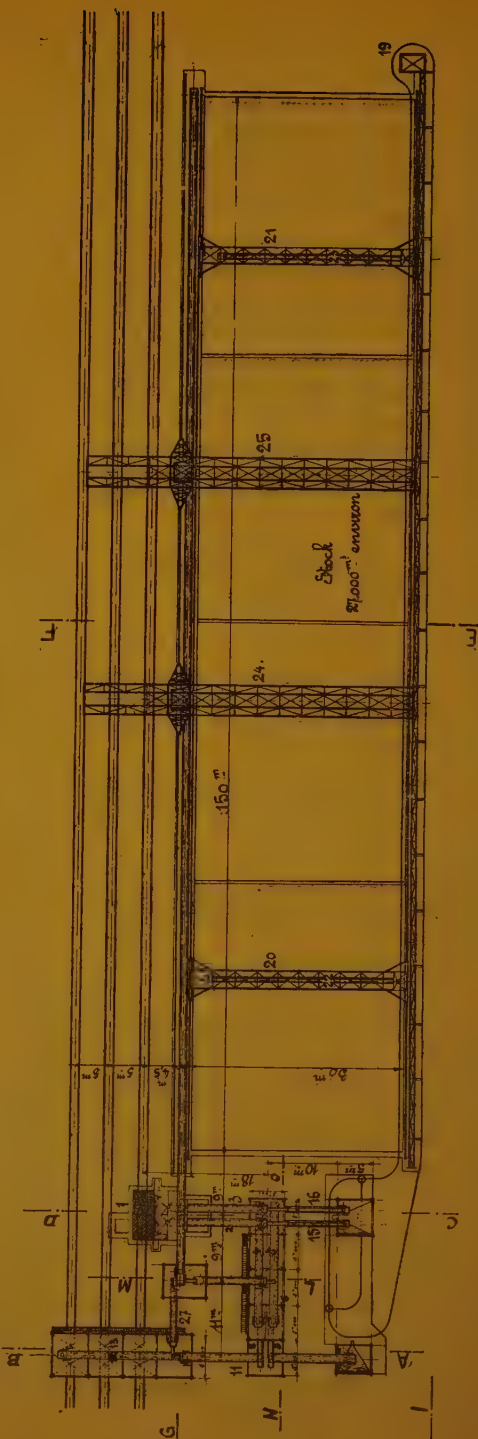
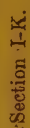
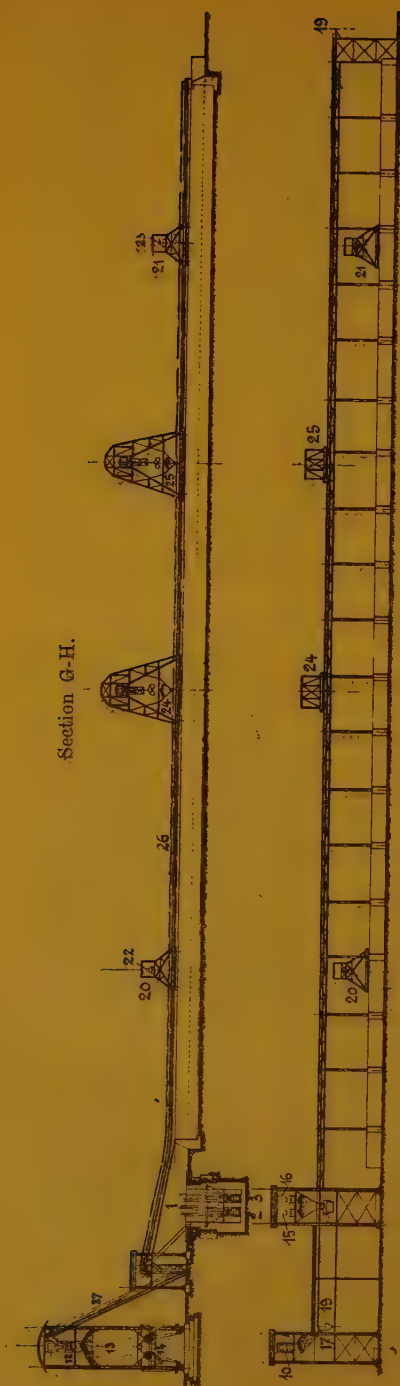
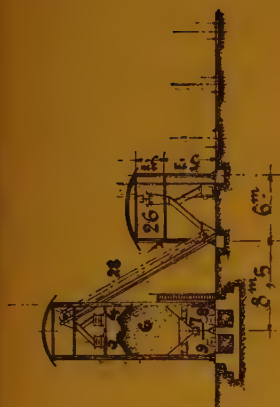
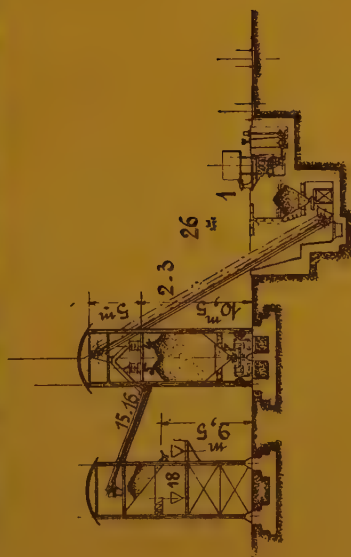
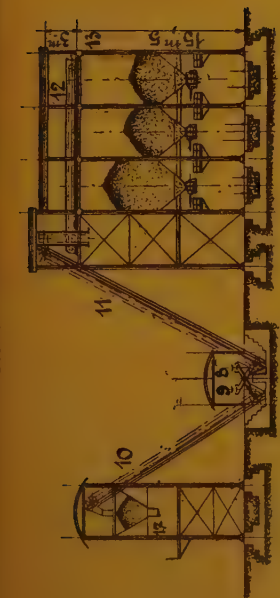


Fig. 15. — New engine shed at Schaerbaek. — Plant for mixing and storing coal.

Section L-M.

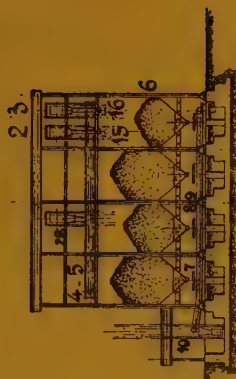


Section A-B.

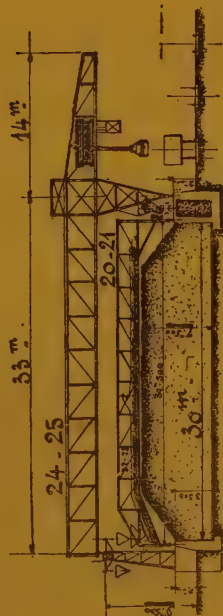


Section C-D.

Section N-O.



1. Wagon tip.
- 2-3. Elevators for unmixed coal.
- 4-5. Chain conveyor.
6. Mixing hoppers.
7. Measuring bins.
- 8-9. Belt conveyors.
- 10-11. Chain conveyors.
12. Chain conveyor.
13. Loading hopper.
14. Measuring bins.
- 15-16. Chain conveyors for unmixed coal.
- 17-18. Hoppers for loading overhead runway.
19. Electric overhead runway with self propelled buckets.
- 20-21. Gantry cranes for dumping coal.
- 22-23. Belt conveyors.
- 24-25. Gantry cranes provided with grabs for picking up coal from stock.
26. Conveyor for coal taken up from stock.
- 27-28. Elevators for coal taken from stock.



Section E-F.

Fig. 45 (continued). — New engine shed at Schaerbeek
Plant for mixing and storing coal.

chain conveyor (12) which conveys it to three hoppers (13) which form a reserve of about 500 t. ready to be loaded into wagons.

These hoppers are provided at the bottom with measuring devices operated electrically from the ground level. An indicator reading to five figures registers the quantities delivered and the total output during the day.

2. Storage dump. — The area of the storage dump operated by the plant is 150 m. long by 30 m. wide (492 feet $\times$ 98.5 feet) and has a capacity of 27 000 t. of fuel. It comprises a circular overhead runway with automatically propelled buckets, two overhead cranes for dumping coal, two overhead cranes provided with a grab for picking up coal, and a conveyor for the coal taken up.

Coal as it comes from the mines is stored in the following manner : the coal is raised by the two elevators and is taken by the conveyors to the hopper from which it is loaded into the buckets of the overhead conveyor (18).

This is provided with a shoot operated by hand by means of a lever; the overhead runway (19) for the automatically propelled buckets runs from the hopper along the coal storage dump and passes over the hoppers of the two overhead cranes which are used for dumping the coal.

A short section of this runway is cut out of circuit and causes the buckets to stop opposite the charging shoot. After shutting the door of the shoot, the operation of filling the buckets energises this section of track, and the buckets proceed on to the section of rail which is kept constantly energised. An automatic block system regulates the distance between the buckets.

By means of a fixed stop and a trigger

carried on the buckets, these are opened while passing over the overhead crane (20) for dumping the coal, and discharge their contents into the hopper carried on the latter.

Under this hopper, a belt conveyor (22) receives the coal, and by means of a tipping device which moves backwards and forwards automatically, the coal is distributed on to the stack.

In order to allow mixed coal to be stocked, a second belt conveyor (9) receives the contents from the measuring device and conveys it to the foot of an elevator (10) which raises it to a second hopper (17) which is also provided with a shoot for loading the buckets of the overhead runway at which the buckets may also be stopped.

The operation of loading is exactly the same as for the unmixed coal, but the stop requires to be changed and placed in such a way that the bucket passes over the first overhead crane and does not open until it reaches the second overhead crane (21) which is specially used for depositing mixed coal. These two operations can be carried out simultaneously, the elevators and the overhead cranes for depositing coal being independent, and in this way, by means of the overhead runway, 60 t. of unmixed coal and 60 t. of mixed coal can be deposited hourly.

Coal, whether mixed or unmixed, may be taken up by means of two gantry cranes (24 and 25), each of which are fitted with an automatic grab which, in case of failure of the plant, or in order to accelerate the unloading of the wagons, may unload coal directly on to the stack, the wagons being so placed that they are opposite the part of the stack containing coal of the required quality.

If, through delay in the deliveries, coals of a certain class are not available, this may be taken from the stack by means of

grabs and then by a transporter (26) along the length of the dump to the elevator (28), and taken by one of the conveyors (4 or 5) which deposits it in the empty bunker.

In this way a temporary shortage of any particular class of coal does not affect the mixture.

If there is a complete cessation of deliveries, the distributing hoppers would be fed by mixed coal taken from the stack by means of the gantry cranes (24 or 25), the conveyor (26) which runs the length of the dump, the mixed coal elevator (27) and the conveyor (12) at a rate of 60 t. per hour.

The second gantry crane for picking up coal may also take mixed coal and load directly into wagons at the rate of 60 t. per hour.

Staff necessary for working the plant.

1° Mixing. — The wagon tip is capable of an hourly output of 120 t., provided that the coal arrives in 20 t. wagons having two openings (four doors) in each side.

Two men are necessary for this work; they get into the wagon and complete the unloading by means of shovels.

In the upper part of the mixing plant, one man only controls the following :

- 1° the conveyors;
- 2° the elevators and their accessories.

At the lower portion of the mixing plant, one man regulates and controls the working of the measuring devices, of the two belt conveyors for the mixed coal and of the two lifts, one taking the mixed coal to the hopper from which it is loaded into the buckets of the runway, and the other towards the bunkers from which it is loaded into wagons. In the second case, he would have in the first place to set in

motion the distributing conveyor above the bunkers.

The operation of the measuring hoppers is entrusted to one or two men as may be necessary.

2° Unloading unmixed coal on to the stack. — The movement of the overhead crane for dumping the coal to the proper position along the stack and the supervision of the belt conveyor and tipping is carried out by the man who loads and despatches the buckets of the overhead runway.

As soon as the bucket has passed out of the first section, the automatic block system comes into operation.

3° Unloading mixed coal on to the stack. — The operation of the overhead crane for depositing mixed coal and the supervision of the conveyor and tipping is carried out by the man who loads and despatches the buckets of the overhead runway from the hopper at which they are loaded with mixed coal.

As has been already said, an electrical device operated by a trigger on the bucket cuts off the current from the section of the runway opposite the loading shoot. The buckets which have a trigger on the right hand side are stopped opposite the mixed coal shoot, and the buckets which have a trigger on the left hand side stop opposite the unmixed coal shoot, and only open over the corresponding overhead crane for dumping the coal on to the stack.

4° Mixed coal or unmixed coal is taken up from the stack by two men, that is, one on each of the gantry cranes.

The operator, before entering his cabin, sets in motion the conveyor running along the coal stack.

The operation of the « by-pass » at

the head of the elevators and the starting of the two elevators for coal taken from stock, either mixed or unmixed, is carried out by men in the upper storey of the mixing plant in the case of unmixed coal, or by the man on the lower stage in the case of mixed coal.

Operating costs.

We will consider, in order to discuss this point, certain typical cases, estimating in the first place the cost of the labour and electrical energy :

1° The unloading, mixing, storing and cealing on to tenders or loading into wagons may be carried out by five men (operating the mixing plant only).

The cost of current is fixed at 0 fr. 40 per kw.-h., and the wages of the man (including all expenses and bonuses) is 20 fr. per eight-hour day.

Per shift of eight hours the plant can deal with 450 t.

Labour	100 fr.
Electrical energy : 40 kw.-h. $\times$ 8 $\times$ 0 fr. 40 =	128 fr.
Total.	228 fr.

Cost per tonne :

$$\frac{228 \text{ fr.}}{450} = 0 \text{ fr. } 50;$$

2° By putting an additional man to load the buckets for depositing mixed or unmixed coal, the plant would be capable of :

a) delivering from the mixing apparatus 450 t. of mixed coal;

b) depositing on the stack 450 t. of mixed or unmixed coal.

Labour	120 fr.
Electrical energy : 50 kw.-h. $\times$ 8 $\times$ 0 fr. 40 =	160 fr.
Total.	280 fr.

Cost per tonne of mixed coal deliver-

ed, or of unmixed coal deposited on the stack :

$$\frac{280 \text{ fr.}}{900} = 0 \text{ fr. } 31;$$

3° If the whole of the coal mixed (900 t. per shift) is put into stock, under these conditions five men would be sufficient.

Labour	100 fr.
Electrical energy : 50 kw.-h. $\times$ 8 $\times$ 0 fr. 40 =	160 fr.
Total.	260 fr.

Cost per tonne of mixed coal and deposited on the stack :

$$\frac{260 \text{ fr.}}{900} = 0 \text{ fr. } 29;$$

4° If the whole of the unmixed coal is placed on the stack (900 t. per shift), this requires three men.

Labour	60 fr.
Electrical energy : 50 kw.-h. $\times$ 8 $\times$ 0 fr. 40 =	160 fr.
Total.	156 fr.

Cost per tonne of unmixed coal put on the stack :

$$\frac{156 \text{ fr.}}{900} = 0 \text{ fr. } 17;$$

5° In the case of complete stoppage, the coal necessary for mixing purposes would be taken from stock. In this case to pick up the unmixed coal, to carry out the mixing, place it in the storage hopper and to coal engines or load it into wagons, four men are sufficient :

Labour	80 fr.
Electrical energy : 40 kw.-h. $\times$ 8 $\times$ 0 fr. 40 =	128 fr.
Total.	208 fr.

Cost per tonne of coal mixed composed of unmixed coal taken from stock :

$$\frac{208 \text{ fr.}}{450} + 0 \text{ fr. } 17 = 0 \text{ fr. } 46 + 0 \text{ fr. } 17 = 0 \text{ fr. } 63;$$

6° The cost per tonne of mixed coal taken from stock by the automatic grab and issued by the measuring bins may be taken as follows :

One man situated at the grab is able to send to the despatching towers, by means of the conveyor and other apparatus, 450 t. per eight-hour shift with an hourly consumption of 20 kw.-h. of electrical energy.

Labour	20 fr.
Electrical energy : 20 kw.-h. $\times$ 8 $\times$ 0 fr. 40 =	64 fr.
Total.	84 fr.

$$\frac{84 \text{ fr.}}{450} = 0 \text{ fr. } 19.$$

The cost per tonne of mixed coal put in stock being 0 fr. 31, the cost of a tonne of mixed coal taken from stock and issued by the measuring bins would be :

$$0 \text{ fr. } 19 + 0 \text{ fr. } 31 = 0 \text{ fr. } 50.$$

Total cost.

It will be seen from these examples that the average cost of labour and electrical energy per tonne of mixed coal issued may be taken as being in the neighbourhood of 0 fr. 50.

The plant can easily deal with 270 000 t. per year. The cost of interest and depreciation and cost of upkeep may be taken as representing a total of 300 000 fr. per annum, that is :

$$\frac{300\,000 \text{ fr.}}{270\,000} = 1 \text{ fr. } 10 \text{ per tonne of coal handled.}$$

The average cost per tonne of coal mixed and dealt with thus comes to a total inclusive figure of 1 fr. 60. The expense becomes of less importance if one considers the great advantages of coaling engines with a mixture of coal of constant quality, as regards regularity of service and economies in coal consumption.

Unless a satisfactory mixture is supplied, one experiences constant trouble with late running, non-steaming, casualties and excessive fuel consumption, which put the traffic department to considerable expense.

It should also be remarked that a plant of this kind allows the storage dumps to be decreased to a minimum at the sheds which it supplies. The mixed coal is in fact regularly sent to the sheds in hopper wagons, and is unloaded by merely opening the doors, either into the pits from which it is raised by elevators into bunkers carried above the line on which engines stand to be coaled, or else into coal tubs which are raised by lifts on to a coal stage, as at Schaerbeek, or in cases of sheds of secondary importance, into tubs which are emptied over the tenders by means of simple fixed electric cranes.

e) Plant for dealing with cotton waste used for cleaning engines.

This plant consists of a turbine extractor separator driven by steam for removing the oil from the waste, a mechanical washer for washing the waste after the oil has been removed, a drying chamber for the washed waste, and two settling tanks for clarifying the oil extracted. The cotton waste and the mixture of oil and paraffin thus recovered answers very well for the first operations of engine cleaning, and they allow an economy to be effected in the consumption of these materials of about 35 %. This plant, after allowing for all expenses, shows an appreciable profit.

f) Oil store.

The oil store is placed between the two approach lines at the end of the shed, and is laid out on the principle of the

« Brevo » type of petrol store, so as to provide the maximum security against the risk of fire or explosion. Six cylindrical vessels of steel, each containing

15 000 litres (3 300 English gallons), and coupled up in pairs, are placed in the basement of the lamp room, and hold lubricating oils and paraffin (fig. 16);

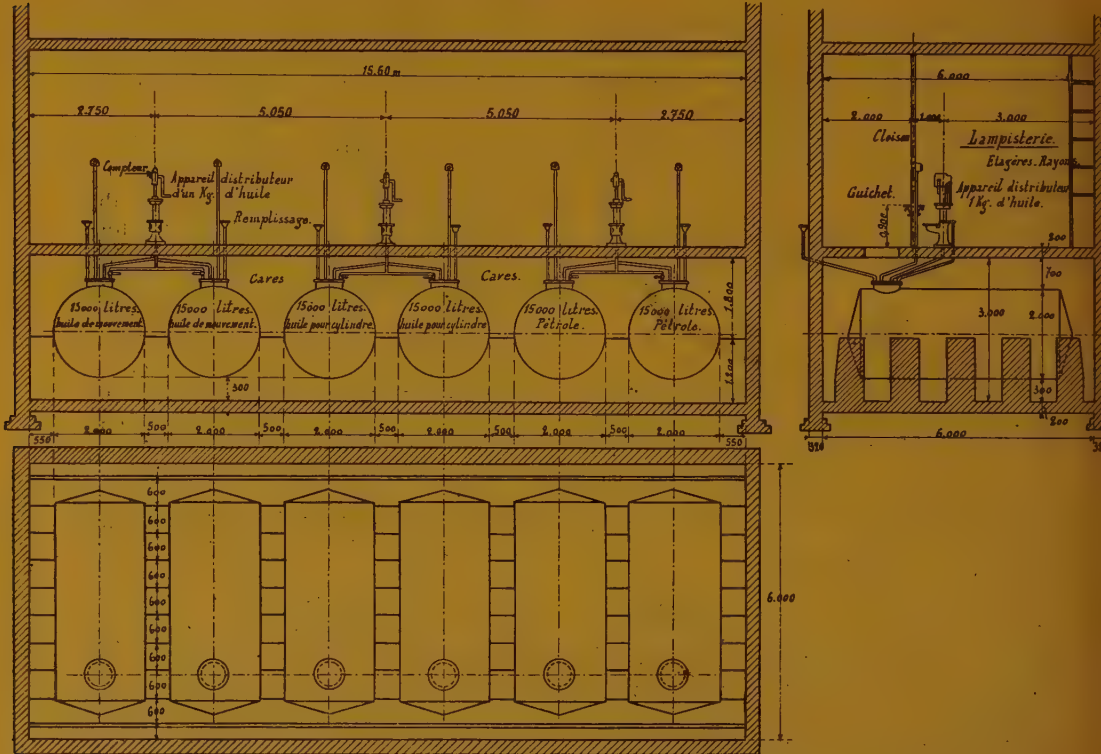


Fig. 16. — Schaerbeek Shed. — Arrangement of reservoirs constructed to minimise risk of explosion and an automatic apparatus for issuing oil. — Six reservoirs of 15 000 litres (3 300 English gallons) capacity 90 000 litres (19 800 English gallons).

Translation of French terms : Appareil distributeur d'un kgr. d'huile = Apparatus for issuing 1 kgr. of oil. — Compteur = Counter. — Remplissage = Filling pipe. — Caves = Vaults. — 15 000 litres huile de mouvement = 15 000 litres engine oil. — 15 000 litres huile pour cylindre = 15 000 litres cylinder oil. — 15 000 litres pétrole = 15 000 litres petroleum. — Lampisterie = Lamp room — Guichet = Window from which oil is issued. — Cloison = Partition.

they are filled directly from tank-wagons. Each reservoir is provided with a man-hole fitted with a safety appliance to guard against explosion which is based on the cooling properties of wire gauze. It comes into operation if any abnormal

increase in temperature melts the joint of special solder.

The building, situated over the vault, is used as a lamp room, and contains the distributing apparatus. On each pair of reservoirs is provided a measuring pump

which delivers exactly 1 kgr. (2.2 pounds) of oil or paraffin for a complete stroke of the piston. It may also be set to issue 100, 200, 300 gr., etc. (0.22, 0.44, 0.66 pound) for a corresponding fraction of the piston stroke by putting a stop into one of the notches provided in the column of the pump. Any quantity issued is automatically registered by a mechanical counter. The pump is provided with a trough which catches the drops of oil spilled, and returns these to the reservoir. It also contains an apparatus which

allows the output to be regulated in case of variation of the density of the oil in such a way as to always deliver the same weight of oil. The quantities of oil contained in each of the tanks may at any time be ascertained by means of a special gauge. The chief features of this oil store are its simplicity, security against fire, its cleanliness and the ease with which the reservoirs may be filled, or with which the oil may be measured out and issued.

The electrification of the Swiss Federal Railways.

Report of the general management of the Swiss Federal Railways, Berné.

Figs. 1 to 19, pp. 1124 to 1148.

The electrification of the Swiss Federal Railways (C. F. F.) having now reached a stage in development appreciably more advanced than that described in the report on electric traction in Switzerland ⁽¹⁾ made by Mr. Huber, engineer, at the Rome Congress of the International Railway Association in 1922, the following notes may prove of interest to readers of the *Bulletin*.

CHAPTER I.

Progress of the work of electrification.

At the time when Mr. Huber, completed his report, at the commencement of 1921, the Swiss Federal Railways were working by electricity entirely and exclusively 123 miles ⁽²⁾ of track of which 47 miles (Iselle-Brigue-Sion) were with

⁽¹⁾ *Bulletin of the International Railway Association*, October 1921 : " Report No. 1 (Switzerland) on the question of electric traction (subject VIII for discussion at the ninth Congress of the International Railway Association) ", by E. HUBER, Ing. dipl., permanent consulting engineer to the General Management of the Swiss Federal Railways, acting chief engineer for the electrification.

⁽²⁾ Out of a total of 420 miles then electrified in Switzerland (not including local lines, the working of which partakes rather of the character of a tramway service carrying light traffic only) these 420 miles comprise :

<i>Continuous current :</i>	
Fribourg-Morat-Anet	20.5 miles.
<i>Three-phase current :</i>	
Berthoud-Thoune and Langnau	34.8 miles.
Iselle-Sion (C. F. F.)	47.2 —
	82.0 —
<i>Single-phase current :</i>	
Scherzligen-Brigue (Lötschberg).	52.2 miles.
Spiez-Bönigen.	12.4 —
Various lines in the Canton of Berne	55.9 —
Various lines of the C. F. F.	75.8 —
Various lines of the Rhätian (narrow-gauge) railways	120.5 —
	316.8 —
Total.	419.3 miles.

three-phase current at 3 300 volts 16 2/3 cycles and 76 miles (Berne-Scherzliggen and Erstfeld-Biasca) single-phase current at 15 000 volts 16 2/3 cycles (see fig. 1).

At present (end of March 1924) electricity has replaced steam on the C. F. F. railway system over a total length of 326 miles ⁽¹⁾, of which 47.2 miles (the same as in 1921) are still being worked with three-phase current at 3 300 volts 16 2/3 cycles; whereas over 279 miles are worked by single-phase current at 15 000 volts 16 2/3 cycles; and 268 1/2 miles of

track are moreover being equipped for single-phase electric traction (see fig. 2).

The C. F. F. are to-day working 203 miles of line more than at the beginning of 1921 in accordance with the general electrification programme adopted in 1918, which had in view the electrification of the whole of the C. F. F. railway system (approximately 1 802 miles) in about thirty years, at the rate of 62 miles of line per annum.

The 1918 programme which was to remain in force till now, was modified last year in such manner that the work of electrification will be appreciably accelerated during the next few years, so that the electrified system of the C. F. F. will at the end of 1928 have a total length of 973 miles (see fig. 3), instead of the length of about 624 miles as provided for in the old programme of 1918.

This acceleration of the work of electrification was settled during 1923 as the result of the decision of the Federal Chambers to make a grant of 60 million francs for this purpose to the C. F. F. (which is a State enterprise keeping separate accounts) being an allocation for service rendered to the Confederation by this department. It will have the effect of materially increasing the amount of employment in the country, and will thus assist Swiss industry in surmounting the unemployment trouble from which the country is still suffering.

(1) Of a total of 674.1 miles electrified in Switzerland, (taking no account of the local lines, the working of which partakes more of the character of a tramway carrying light traffic) these 674.1 miles comprise :

<i>Continuous current :</i>	
(As in preceding note 2) . .	20.5 miles
<i>Three-phase current :</i>	
(As in preceding note 2) . .	82.0 —
<i>Single-phase current :</i>	
Scherzliggen-Brigue (Lötschberg)	52.2 miles
Spiez-Bönigen	12.4 —
Various lines in the Canton of Berne	55.9 —
Various lines of the C. F. F.	279.0 —
Various lines of the Rhaetian (narrow-gauge) railways	172.1 —
	571.6 —
Total. . .	674.1 miles



Fig. 1. — Electrification of the Swiss Federal Railways at the commencement of 1921.

EXPLANATORY NOTE :

- Electrified lines of the C. F. F. (423 miles).
- Lines of the C. F. F. in process of being electrified (491 miles).
- Generating stations of the C. F. F. working.
- Generating stations of the C. F. F. in course of construction.
- Private generating stations supplying electric power to the C. F. F.
- High-tension transmission lines.
- Sub-stations of the C. F. F.
- Chemins de fer rhétiques = Rhaetian railway system. — Chemins de fer de la Bernina = Bernina railway system.

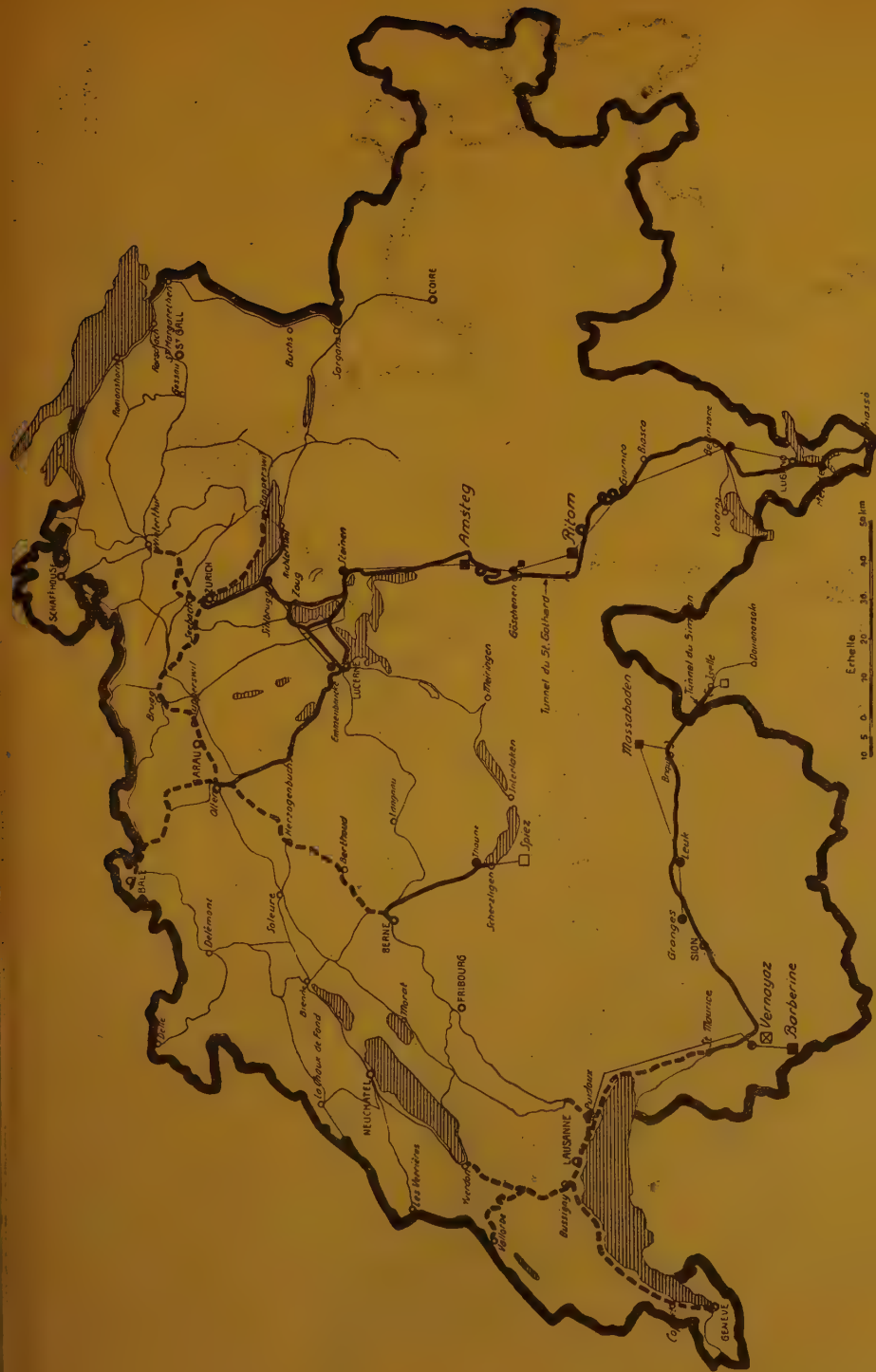


Fig. 2. — Electrification of the Swiss Federal Railways at the end of March of 1924.

EXPLANATORY NOTE :

- Electrified lines of the C. F. F. (326 miles).
- Lines of the C. F. F. in process of being electrified (263 miles).
- Generating stations of the C. F. F. working.
- Generating stations of the C. F. F. in course of construction.
- Private generating stations supplying electric power to the C. F. F.
- High-tension transmission lines.
- Sub-stations of the C. F. F.



Fig. 3. — Electrification of the Swiss Federal Railways at the end of 1928.

EXPLANATORY NOTE :

Electrified lines of the C. F. F. (973 miles).

Generating stations of the C. F. F. working.

Private generating stations supplying electric current to the C. F. F.

Lines for transmission at very high tension, 135 000 volts.

Lines for transmission at high tension, 60 000 volts.

Main transformer stations 135 000/60 000 volts.

Feeder sub-stations, 60 000/15 000 volts.

CHAPTER II.

General scheme.

The 973 miles arranged to be electrified by the end of 1928, comprise nearly all the main lines of the C. F. F. railway system.

Of these 973 miles, the international section through Brigue to Iselle (13.6 miles) alone will remain permanently worked with the three-phase current supplied to Brigue by the small Massaboden power-station of the C. F. F., and at Iselle by the « Dynamo » Company of Milan. (The section from Brigue to Sion at present worked by three-phase current, will shortly be altered to single-phase and connected electrically to the remainder of the railway system.) The other lines of a total length of 959 1/2 miles, are supplied with single-phase current at 15 000 volts and 16 2/3 cycles supplied mainly from the two powerful hydro-electric generating station systems of the C. F. F. at Ritom-Amsteg and Barberine-Vernayaz, connected together by a supply line of very high tension crossing the whole of the Swiss plateau (see fig. 3).

The extreme easterly section of the C. F. F. railway system will, as at present arranged, be supplied from the generating station at Küblis, utilising the Grisons water power, which at the present time supplies the single-phase current required for the electric working of a portion of the Rhaetian railways.

In the central area in the vicinity of Berne, the Spiez generating station utilising the Bernese water power, will continue to supply the Berne-Scherzligen section, which it supplies at the present time, at the same time as the Lötschberg and various lines of the Canton of Berne. The single-phase current of the Swiss Federal railways will, moreover, later be

connected with the three-phase supply system of the Bernese water-power generating stations by means of rotary converters installed in the Mühleberg generating station ⁽¹⁾ belonging to this Company.

The hydro-electric generating stations of Ritom, Amsteg, Barberine, Vernayaz and Küblis, all situated in the immediate neighbourhood of the Alps, will be connected by a group of transmission lines of a total length of 683 1/2 miles to 25 sub-stations required for feeding the overhead conductor on the tracks (the distance between two sub-stations will in no case exceed 37.3 miles). Apart from the main transmission 143 miles in length, carrying 135 000 volts from Vernayaz to Rapperswil (see fig. 3), all the transmission lines (about 540 miles) which distribute energy to the sub-stations, will be worked at 60 000 volts.

The sites for the 25 sub-stations required for feeding the 959 1/2 miles of railway line to be equipped for single-phase traction current up to the end of 1928, have been chosen in such manner that it will only be necessary to add three or four additional sub-stations later to suffice for the supply for the whole of the railway system of the C. F. F. (about 1 800 miles).

The five generating stations of the C. F. F. at Massaboden, Ritom, Amsteg,

(1) It is proposed that the converter groups at Mühleberg should work both ways, that is, for transforming the three-phase power, purchased by the C. F. F. for their requirements, into single-phase current, or for transforming into three-phase current, for use by the Bernese water-power Company, any excess of single-phase current which the C. F. F. can spare from their generating stations.

Barberine, and Vernayaz, with the help of the private generating stations at Spiez, Mühleberg, and Küblis, will be able to supply, when working at full load ⁽¹⁾ about 490 000 000 kilowatt-hours at the terminals of the generators. Of this 490 000 000 kw.-h., 400 000 000 in round figures ⁽²⁾ will probably be used from 1929 onward, provided that the anticipated recovery of traffic takes place.

It is estimated that this amount of energy will be sufficient for the amount of traffic required by 6 115 000 000 English ton-miles inclusive of the locomotives.

In order to ensure the possibility of obtaining efficient use of the hydro-

electric central generating stations at all times, even when the traffic on the electric lines is not sufficiently great to absorb the whole of the energy available at any season, the C. F. F. have installed, at Amsteg, a three-phase generator of 9 000 kw. and 50 cycles, which enables them to put their excess power at the disposal of private enterprise. It is also intended to install a three-phase, 50 cycle generator at Vernayaz for the same purpose. A portion of the excess power of the C. F. F. could moreover be diverted by means of the rotary convertors installed in the Mühleberg station to the Bernese Water Power Company.

CHAPTER III.

Cost of electrification.

The total cost of electrification up to the end of 1928 (for a total of 973 miles) was estimated in 1923 at 760 million francs, for only 700 000 000 of which the C. F. F. will be responsible, an allowance of 60 000 000 francs being made to the

Confederation for accelerating the work of electrification. This 700 million francs will be divided approximately among the various installations and purchases which have to be made as follows :

Central-hydro-electric generating stations of the C. F. F. (capacity brought up to 430 000 000 kilowatt-hours.).	fr. 150 000 000. — 21.4 %
Transmission lines (about 683 miles of which 37.2 miles, are to be laid in underground cable between Giornico and Amsteg).	55 000 000. — 7.9 %
Sub-stations (see observations below)	60 000 000. — 8.6 %
Overhead conductors (see observations below).	125 000 000 — 17.9 %
Non-recurring expenses (see observations below).	100 000 000. — 14.2 %
Rolling stock (see observations below)	210 000 000. — 30.0 %
Total approximate 1923 value (see observations below).	fr. 700 000 000. — 100 %

(1) Of which : Massaboden (C. F. F.)	40 million kw.-h. (three-phase).
Ritom-Amsteg (C. F. F.)	190 — — (single-phase).
Barberine-Vernayaz (C. F. F.)	230 — — —
Spiez and Mühleberg (private).	20 — — —
Küblis (private)	40 — — —

Total. . . 490 million kw.-h.

(2) Of which : Massaboden	} Power stations of the C. F. F., about 370 million kw.-h. (Consumption expected in 1929, about 85 % for traction.)
Ritom-Amsteg	
Barberine-Vernayaz	
Spiez (and Mühleberg)	
Küblis	
	About 5 million kw.-h.
	— 25 — —

Observations.

a) SUB-STATIONS. — The sum of 60 000 000 francs represents the capital outlay on 25 sub-stations, transforming from 60 000 down to 15 000 volts, required for feeding the electrified railway system, and also the two main transformer stations, transforming from 135 000 down to 60 000 volts at Chiètres near Mühleberg and at Rapperswil. In this amount is included the capital invested in the new repair shops at Bellinzona, Zurich, and Yverdon, which have effected an economy by replacing the old workshops, the dimensions of which were too small for the large and more powerful electric locomotives that are even larger than the old steam locomotives without tenders. The cost of alterations to the locomotive repair shops and sheds is also included in this sum.

b) CONDUCTOR LINES. — The sum of 125 000 000 francs includes the cost of the overhead contact lines on the tracks, the cost of the lines carried round the stations and stopping places, and the feeders between the sub-stations and the contact lines, the auxiliary lines running along single tracks, the installations for section working, and the bonding of the rails. This sum relates to 959 $1/2$ miles of single-phase line at 15 000 volts; and 13.6 miles of three-phase line at 3 300 volts, covering about 2 240 miles of track with about 380 goods and passenger stations.

c) NON-RECURRING EXPENSES. — The sum of 100 million francs comprises, apart from a considerable amount set aside for unforeseen expenses, all expenses incurred since the commencement of electrification and to be incurred up to the end of 1928 for acquiring concessions of hydraulic power, not only of the hydraulic power

utilised in the generating stations of Mas-saboden, Ritom, Amsteg, Barberine and Vernayaz, but also other hydraulic supply sources which the C. F. F. have kept in reserve for subsequent use; it also comprises all expenses incurred up to the present and to be incurred up to the end of 1928, for all the schemes to be drawn up for electrification, for designing, for the preparation of the drawings, and for the management and general supervision of the work to be executed.

The sum of 100 million francs also includes the cost of the modifications to be made in existing installations (dropping the tracks in the tunnels, the raising of superstructures, making modifications in the roofs of awnings and goods warehouses, etc.), in order to afford the requisite loading gauge, the cost of work necessary for making the tunnels more water-tight, as well as the share to be taken by the C. F. F. in the cost of modifications to be made in the low tension current installations (telegraphs and telephones).

These last named expenses comprise in particular the cost of replacing, as cable, or moving to a distance the overhead telephone and telegraph wires of the C. F. F. and of the Federal Post and Telegraph Department, it not being possible to keep these on the track, as at present, because the fact of their being in the immediate neighbourhood of the high tension contact wire is inadmissible for technical reasons (interference arising from induction phenomena caused by the traction current) as well as practical reasons (the occupation of space required for erecting the supports for carrying the contact wires, and danger arising from the running together of two lines of so different a character extending over long distances). The C. F. F. place their low tension current lines in cable under the

track itself, of course at their own expense. On the other hand, the Federal Post and Telegraph Department puts its lines into cable laid along roads as far as possible from the track, when, as occasionally happens, it is not satisfied with moving the overhead lines to one side; of these operations the C. F. F. are required to bear approximately one-third of the cost, under an old law which guaranteed the free use of a portion of the railway track to the Post and Telegraph Department for the installation of its lines.

d) ROLLING STOCK. — The sum of 210 million francs includes the purchase of the electric locomotives and automotor vehicles required up to the end of 1928, as well as the cost of installation of direct electric heating in the passenger carriages.

The number of locomotives and automotor vehicles has been very carefully

considered and is in the proportion of 90 electric tractors to 100 steam tractors required before the electrification is effected. The future will show how far this proportion could be improved in practice on that portion of the C. F. F. railway system which forms a very close network.

e) TOTAL APPROXIMATE ESTIMATED VALUE IN 1923. — The total cost of electrification having been estimated recently at 760 millions francs, and the subsidy of 60 million francs to the Confederation, corresponding roughly to the special extra cost (this extra cost has been recently calculated at an amount in round figures of 75 million francs as compared with the prices in 1923) which affects installations carried out during the war, so that the total of 700 million francs is a very fair figure for the estimated total cost of electrification in 1923.

CHAPTER IV.

Brief description of the main installations.

A. — Hydro electric generating stations of the C. F. F.

a) RITOM GENERATING STATION. — The Ritom generating station (fig. 4) is situated to the south of the Saint-Gothard tunnel close to the railway running from Lucerne to Chiasso in Italy.

The waters of the Ritom Lake are used, taken through a tunnel arranged 98 feet below the natural water level of the lake, which is used as a storage basin, and has a mean gross fall of approximately 2 660 feet. The level of the lake has been raised by 23 feet, by means of a dam with a view to increasing the amount of

water available in winter. The effective volume of the Ritom Lake has thus been brought up to 939 420 000 cubic feet.

The Ritom generating station ⁽¹⁾ has installed at present four turbines of 12 200 metric H. P. running at 333 1/3 revolutions per minute, coupled to four single-phase generators of 16 2/3 cycles and 15 000 volts.

(1) See the technical details given in regard to the Ritom generating station in "Das Kraftwerk Ritom der Schweizerischen Bundesbahnen" by the engineers H. EGGENBERGER and H. HABICH, and the architect TH. NAGER, reprinted from the *Schweizerische Bauzeitung*, Zurich, 1923.

Except in particularly dry years, this generating station can supply, at the terminals of the generators, at least 40 000 000 kilowatt-hours, which, accord-

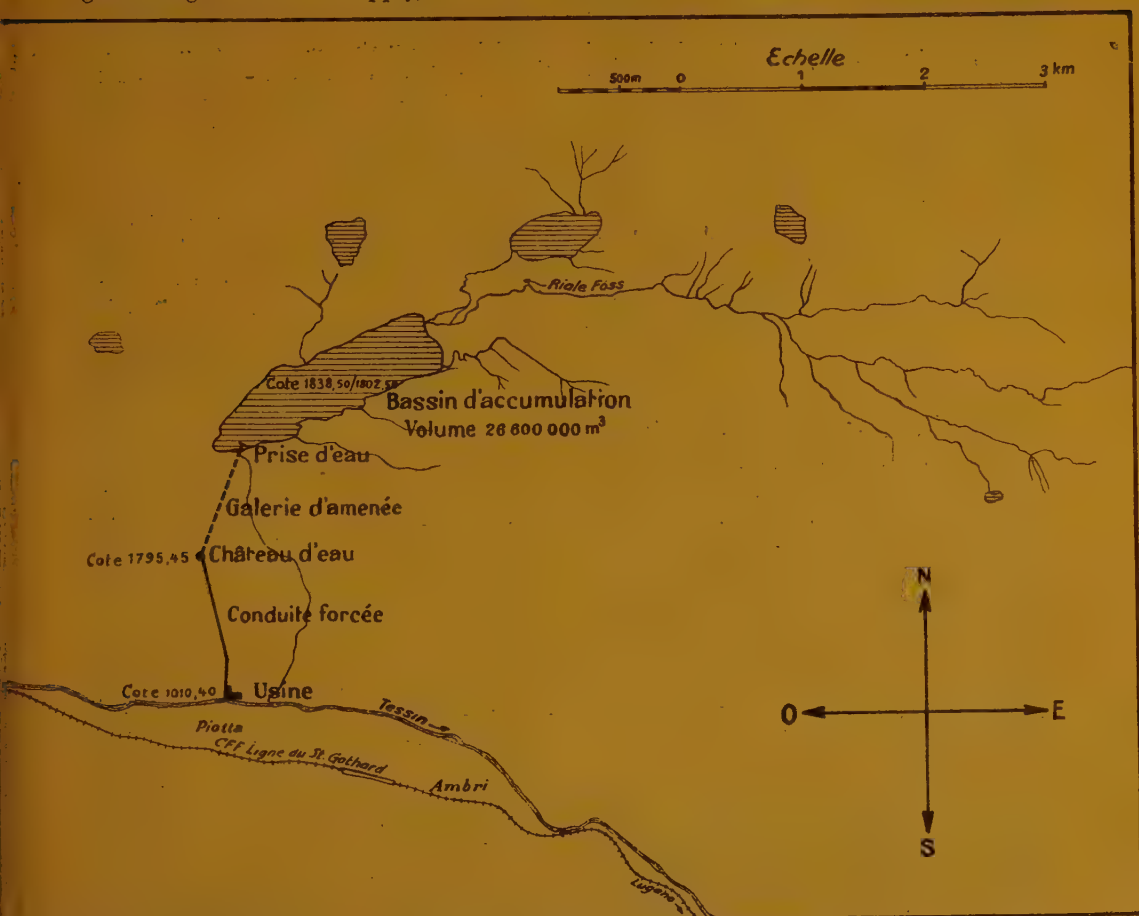


Fig. 4. — Ritom : sources of power.

Explanation of French terms : Côte = Height (metres above datum). — Bassin d'accumulation : volume 26 600 000 m³ = Storage lake (939 420 000 cubic feet). — Prise d'eau = Water intake. — Galerie d'amenée = Water tunnel. — Château d'eau = Service house. — Conduite forcée = Pipe line. — Usine = Generating station. — Ligne du St-Gothard = Gothard Railway. — Echelle = Scale.

ing to requirements, may be distributed over the whole year or concentrated almost entirely over the six winter months from November to April inclusive. The Ritom generating station is entirely independent of the daily variations in flow of the river Foss that feeds the Ritom Lake,

and it is for this reason that the C. F. F. constructed the Ritom generating station before that of Amsteg ⁽¹⁾.

(1) The Ritom generating station commenced work in September 1920; the Amsteg generating station, in December 1922.

b) AMSTEG GENERATING STATION. — The Amsteg generating station is situated at the north end of the St. Gotthard tunnel not far from the Amsteg Railway Station of the C. F. F. It uses the water supplied by the Reuss (and by the Fellibach) on the one hand, and that of the Etzlibach and the Kärstelenbach on the other hand, having a mean gross fall of about 950 feet (fig. 5).

The Amsteg generating station contains six turbines of 14 300 metric H. P., running at $333 \frac{1}{3}$ revolutions per minute, coupled to five single-phase generators of $16 \frac{2}{3}$ cycles, 15 000 volts; and one three-phase generator of 50 cycles, 8 000 volts ⁽¹⁾ used to supply current for private industries from the excess power which the C. F. F. cannot itself use.

The Amsteg generating station has been laid out to supply [in conjunction with the small auxiliary generating station at Göschenen ⁽²⁾] an approximate annual mean supply of 150 million kilowatt-hours for electric traction, of which at least 55 million kilowatt-hours can be supplied during the winter months.

c) THE AMSTEG-RITOM GROUP. — The two generating stations of Amsteg and Ritom can together supply about 190 million kilowatt-hours at the terminals of the generators averaged over the whole year. They will be so combined that the

Amsteg works will be able to run almost alone through the summer thanks to the water supply of the Reuss (and of the Fellibach) and the Kärstelenbach and the Etzlibach, which run very strongly at this time of the year, while the Ritom Lake is filling. In the winter, on the other hand, the Ritom generating station has to supply the whole of the power that the Amsteg generating station can no longer supply on account of shortage of water in the rivers from which it derives its supply.

The power of the turbines and single-phase generators at Ritom and Amsteg has been so arranged that the two generating stations together can at any time supply the peak loads required for the electric traction while making economic use of the water available. The diagrams shown in figure 6 show graphically the approximate division of power and the supply required per 24 hours for the mean traffic: a) in summer when there is available at least 388 cubic feet of water per second at Amsteg (that is to say, for at least 240 days per annum; b) in winter, when there is only a minimum of 127 cubic feet per second available at Amsteg (the minimum which occurs in normal conditions for only a few days in the year).

Examination of the two diagrams shows how it has been possible to determine the minimum power to be installed in Ritom and Amsteg generating stations by making the main demand for power in kilowatt-hours fall in summer on Amsteg and in winter on Ritom; whereas the supply for the small peaks which require several generators without involving heavy water consumption, falls in summer on Ritom and in winter on Amsteg.

By means of a compensating reservoir at Pfaffensprung (see fig. 5) in which

⁽¹⁾ The turbine coupled to the three-phase, 50 cycle generator runs actually at 300 revolutions per minute although constructed for $333 \frac{1}{3}$ revolutions per minute, so that it may be coupled at a later date to a single-phase $16 \frac{2}{3}$ -cycle generator if need should arise.

⁽²⁾ The Göschenen generating station is fitted with a single generating unit consisting of an asynchronous single-phase dynamo of 1 300 kilowatts coupled to a turbine using the water which, prior to the electrification of the line, was used for running the fans for ventilating the St. Gotthard tunnel.

storage may be effected by proper manipulation of the channels communicating with it, of the waters of the rivers Etzli-bach and those of the Reuss, the Amsteg generating station is ensured its supply throughout the winter.

The balancing of the power and of the peaks of the two generating stations is effected automatically by varying the co-efficient of irregularity of the output of the turbines from time to time. Figure 7 shows an actual diagram recorded during trials made at Ritom and Amsteg with an adjusted co-efficient of irregularity taken as an example amounting to 2 % at Amsteg and 5 % at Ritom.

d) BARBERINE GENERATING STATION. — The Barberine generating station is located near Chatelard station of the Martigny-Chamonix line in Valais. It uses the supply of the Barberine and of the Nant de Drance, which feed the artificial lake at Barberine, giving a mean gross head of about 2 430 feet (fig. 8). The Barberine lake is situated at an elevation of 6 000 feet above sea level. The dam of Lake Barberine ⁽¹⁾, which has been in progress of construction since 1922, will not be completed for three years; in its present state it forms a small lake containing a few million cubic metres of water which are used in the Barberine generating station that commenced work in December 1923.

The Barberine generating station will

(1) The Barberine dam is a mass concrete wall containing large pieces of rock ("plums"); it consists of about 7 000 000 cubic feet of concrete; it will measure about 262 feet maximum height, and the crest will be nearly 870 feet in length. For further particulars see "Les travaux de construction du barrage de Barberine", by E. G. CHOISY, engineer, Geneva (*Schweizerische Techniker Zeitung* of 1 November 1923), published by Vogt-Schild, Soleure, Switzerland.

ultimately be fitted with four turbines of 15 600 metric H. P., running at 333 1/3 revolutions per minute, coupled to four single-phase generators of a normal power of 10 000 kilovolt-amperes 16 2/3 cycles, 15 000 volts, capable of supplying 12 700 kilovolt-amperes for a period of 1 1/2 hours with a $\cos \Phi = 0.75$; and of supplying 14 400 kilovolt-amperes for ten minutes. It is capable of supplying about 60 million kilowatt-hours per annum at the generator terminals, of which about 80 % will usually be supplied in winter, in the future.

e) VERNAYAZ GENERATING STATION. — The Vernayaz generating station is situated in the Rhône valley close to the Vernayaz station of the C. F. F. on the Simplon Railway. It is supplied (see fig. 8) with the waters of the Eau Noire, of the Trient, and of the Triège, as well as the water coming from the outlets of the turbines of the Barberine works at Chatelard, with a gross head of about 2 200 feet.

The Vernayaz generating station will be fitted with five turbines of 18 000 metric H. P. running at 333 1/3 revolutions per minute, coupled to five single-phase generators capable of generating, under normal conditions, 11 000 kilovolt-amperes at 16 2/3 cycles and 15 000 volts, and capable of supplying, with a $\cos \varphi = 0.75$, 14 000 kilovolt-amperes for an hour and a half, and 17 100 kilovolt-amperes for ten minutes. A sixth turbine of 18 600 metric H. P. will also be coupled to the three-phase, 50 cycle generator installed for supplying to private industry the excess power, which the C. F. F. cannot use.

The Vernayaz generating station will supply each year at least 170 million kilowatt-hours at the terminals of the generators, of which about 105 million

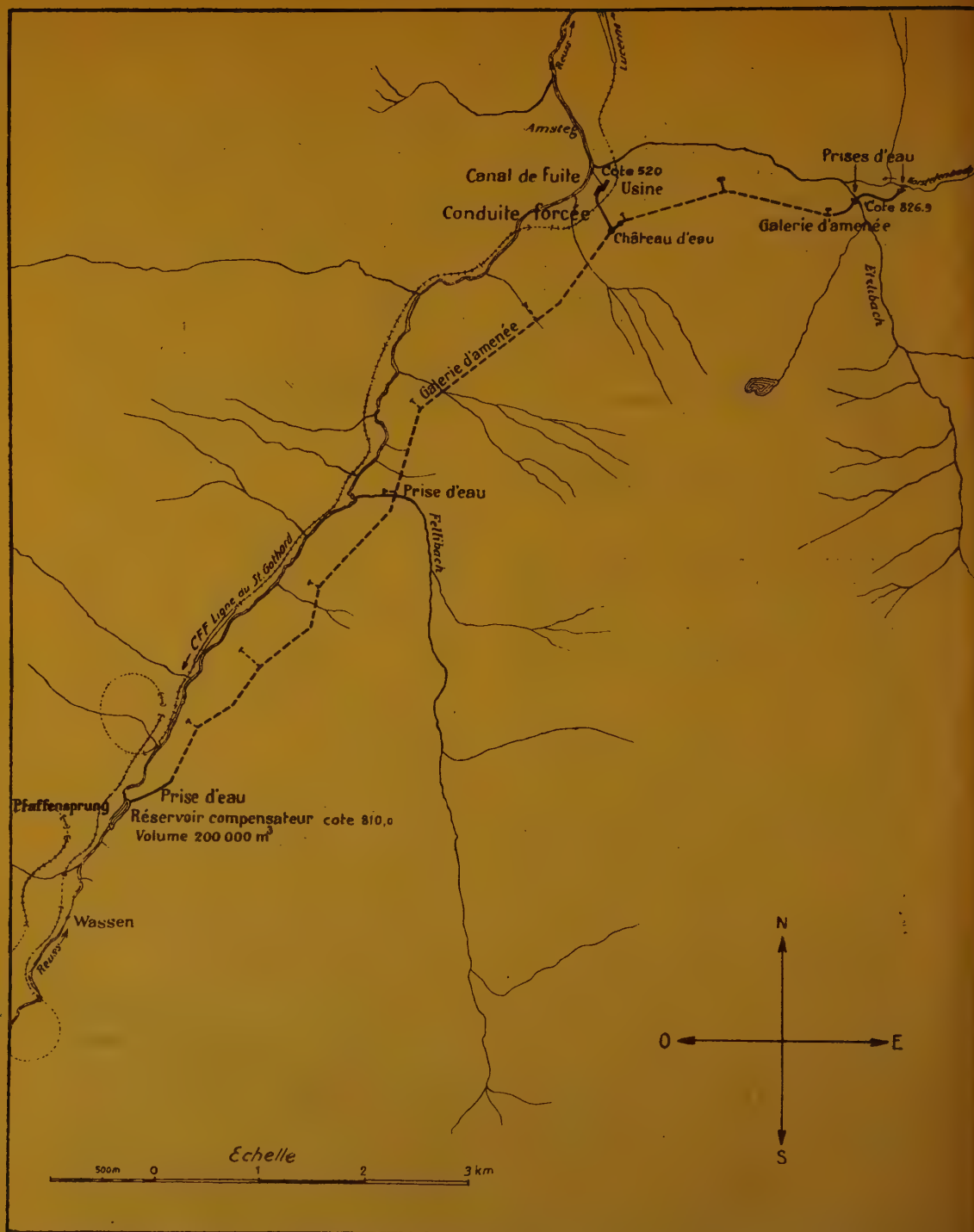


Fig. 5. — Amsteg : Sources of Power.

Explanation of French terms : Cote = Height (metres above datum). — Prises d'eau = Water intake. — Galerie d'amenée = Water tunnel. — Château d'eau = Water tank. — Conduite forcée = Pipe line. — Usine = Generating station. — Canal de fuite = Waste water canal. — Réservoir compensateur = Compensating reservoir. — Ligne du St. Gothard = St. Gothard Railway.

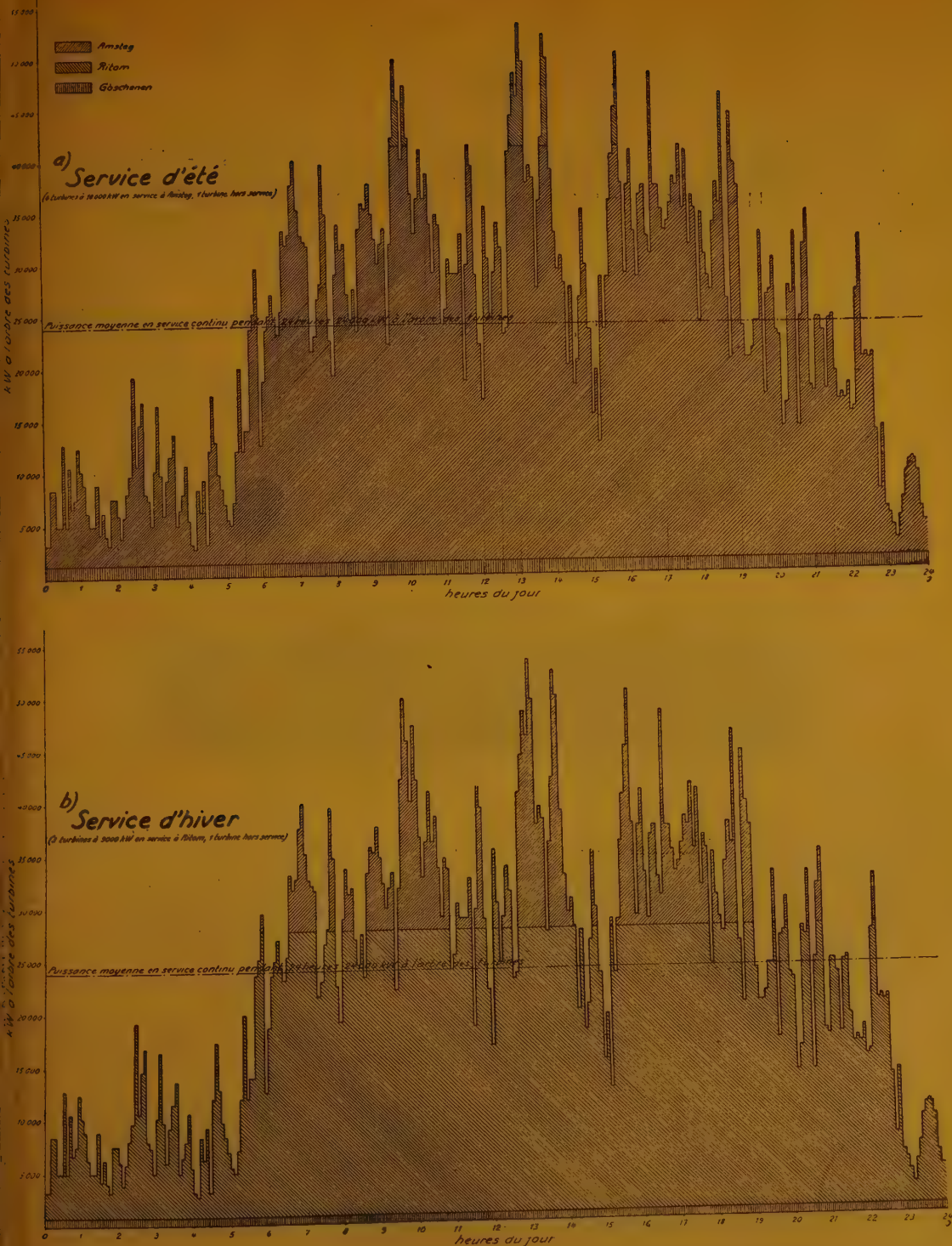


Fig. 6. — Power supplied daily by the Ritom and Amsteg (and also Göschenen) generating stations.
(Theoretical diagram calculated for a day having average traffic.)

Explanation of French terms: Kw. à l'arbre des turbines = Kilowatts at the turbine shaft. — Heures du jour = Time. — Service d'été, etc. = Summer service (four turbines of 10 000 kilowatts, working at Amsteg, one turbine not in use. — Puissance moyenne en service continu, etc. = Average power of continuous service during the 24 hours, 24 000 kilowatts at the turbine shafts. — Service d'hiver, etc. = Winter service, three turbines of 9 000 kilowatts at work at Ritom, one turbine not working.

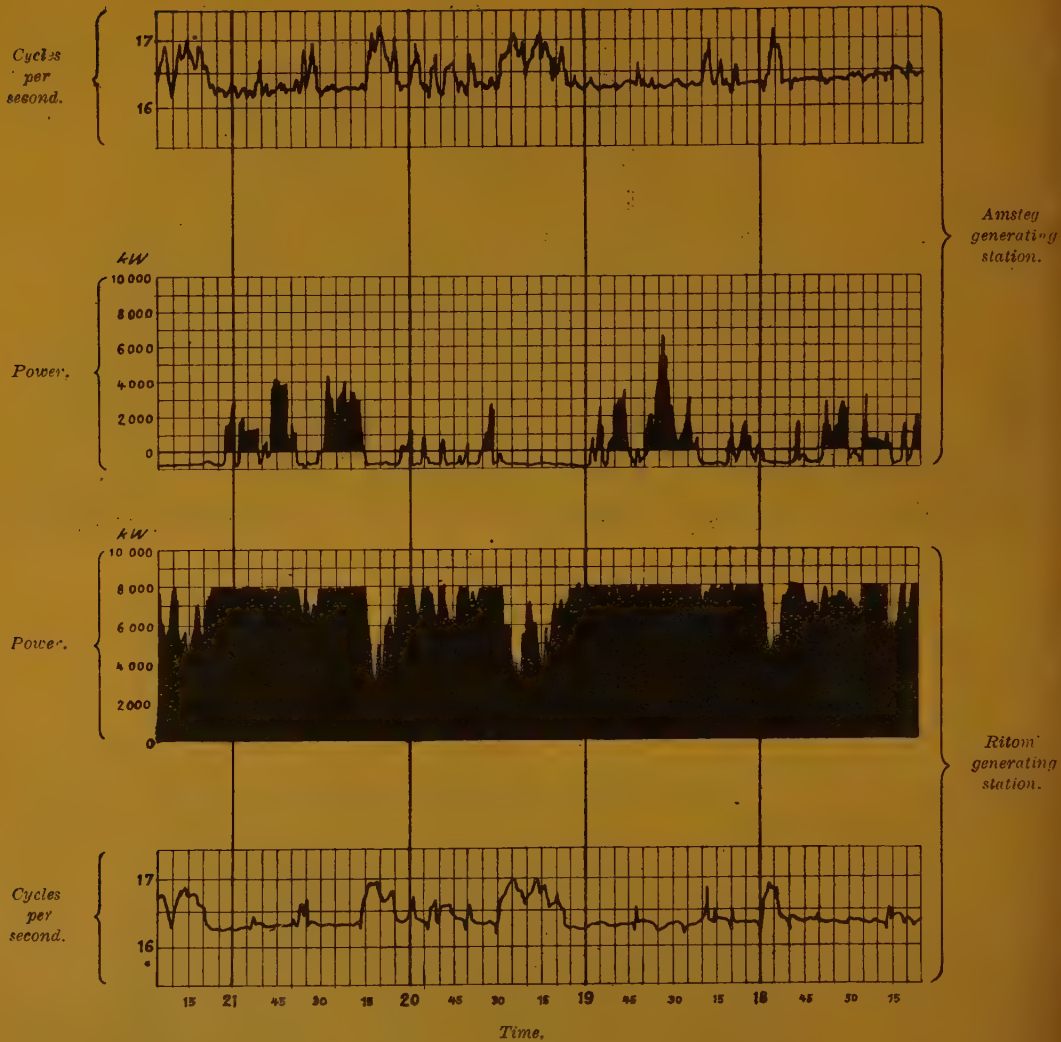


Fig. 7. — Power diagrams of the Ritom and Amsteg generating stations.
Trials made 25 January 1925.

kilowatt-hours will be generated in summer from May to October, and 65 million kilowatt-hours in winter (the 65 million kw.-h. include the power supplied to Vernayaz by the water passing through the Barberine generating station. With-

out this water, the Vernayaz generating station could not deliver, in winter, more than 20 million kilowatt-hours).

f) THE VERNAYAZ-BARBERINE GROUP. — The two generating stations of Barberine

and Vernayaz will be able together to supply about 230 million kilowatt-hours balanced over the whole year, at the generator terminals. This group of generating stations will be run in a similar manner to that described above for the Amsteg-Ritom group; in this case Vernayaz plays the same part as Amsteg does in the other case. The Vernayaz-Barberine combination is, however, more fortunately placed than the Amsteg-Ritom combination, because the water of the Barberine Lake is utilised in the two generating stations one after the other, which has the enormous advantage of allowing the Vernayaz central station to supply about 45 million kilowatt-hours more in winter than it could supply without this assistance.

g) The two groups of hydro-electric generating stations of the C. F. F., the Amsteg-Ritom and the Vernayaz-Barberine, will also be able to supply at the terminals of the generators about 420 million kilowatt-hours of single-phase power averaged over the whole year.

B. — Transmission lines.

The transmission lines, which connect the generating stations to the sub-stations, are carried on iron pylons (fig. 9) as near as possible to the railway lines, and, in cases when the conditions are favourable, alongside the track. Generally speaking, the 60 000 volt lines have copper conductors; the very high tension Vernayaz and Rapperswil line will probably be arranged with aluminium-steel conductors, which at the present time are cheaper.

The two generating stations of Ritom and Amsteg are connected together and as far as the Giornico sub-station over a total length of about 37 miles by underground transmission cables working at $\pm 30\,000$ volts; the cables are carried without trouble through the numerous

tunnels that occur on the St. Gothard line in this district.

C. — Sub-stations.

The sub-stations serve for transforming the high-tension current of the transmission lines into 15 000 volt current on the contact line by means of static transformers.

Transformers installed on the C. F. F. sub-stations have a normal power of 3 000 or 5 000 kilowatts capable of giving 4 500 kilovolt-amperes or 7 500 kv.-a. for half an hour.

All cables leaving the sub-stations are controlled by hand-operated line switches connected in groups to bus-bars and fed through automatic cut-outs which cut out automatically in case of any short-circuiting. These feeder cut-outs are shunted by a resistance which enables the insulation of the lines to be checked after cutting out.

The sub-stations on the Gothard line are of the enclosed type (fig. 10); all sub-stations constructed at a later date or at present being built, are of the much cheaper open-air type (fig. 11).

D — Contact lines.

The contact lines ⁽¹⁾ at present erected (fig. 12) have their main features given in table I below.

E — Overhead lines.

The overhead telegraph and telephone lines of the C. F. F. which have hitherto

(1) See details of the connections of the contact wires of the C. F. F. in "Schaltanordnungen in den Fahrleitungsanlagen der Schweizerischen Bundesbahnen", by H. W. SCHÜLER, engineer (Schweiz. Bauzeitung, Zürich, 14 October 1922).

Table I.

WORKING CURRENT.	SINGLE-PHASE CURRENT.
Cycles per second	16 $\frac{2}{3}$
Voltage at contact lines, volts	15 000
	On main lines in the open. { A single copper contact-wire of 0.166 square inch section. A steel carrying cable 0.077 square inch section.
Method of transmission of working current on the track.	In tunnels. { A contact wire of 0.166 square inch. A bi-metallic carrying wire (of steel, copper covered) of 0.087 square inch.
	In sidings. { A copper contact wire of 0.088 square inch section. An iron carrying cable of 0.077 square inch section.
Return current.	Through the rails connected at feeder points by copper wires laid in the ground.
Electric bonding.	Copper bonds of 0.054 square inch brazed to the railheads.
Suspension of contact-wire and height of contact-wire above the rail . . .	Simple catenary suspension at a height of 18 feet to 21 ft. 8 in. above the rail.
Insulation of the contact-wire . . .	Simple insulation on bell-shaped insulators. In stations in which mixed working (electric and steam) will still continue for some time, extra insulation is used.
Detail of supports for the contact-wires	Pylons and brackets or iron yokes with concrete foundations.
Spacing of the supports	197 to 328 feet, in the open and in the stations, on the straight : intermediary pylons on the curves.

been carried on posts along the track, are now laid in cable in culverts made of cement and laid in the ground alongside the tracks. These cables include not only as many cores as may be necessary to replace the old overhead wires, together with those necessary for the elimination of the earth return, but also a large number of extra wires to provide for an appreciable increase in means of communication. Switch boxes are arranged on the

cables, for enabling telephonic communication to be established without trouble at any kilometre along the track.

F. — Rolling stock.

All the characteristic features concerning electric single-phase locomotives or automotor vehicles of the C. F. F. are given in table II below. The electric locomotives shown as being fitted with



Fig. 9. — Pylon of the C. F. F. transmission line between Amsteg and Steinen.

(View taken in winter from above the Avenstrasse.)

These pylons carry eight conductors for the transmission of single-phase current for the C. F. F., and three conductors for the transmission of the excess power supplied in the form of three-phase current to private works in Amsteg.



Fig. 10. — General view of the Göschenen sub-station (enclosed type.)



Fig. 11. — General view of the Vernayaz sub-station. (Open air type)

To the right is seen the small building containing the measuring appliances, accessory installations, and dwelling house.



Fig. 12. — Contact lines on the Saint-Maurice-Sion section.

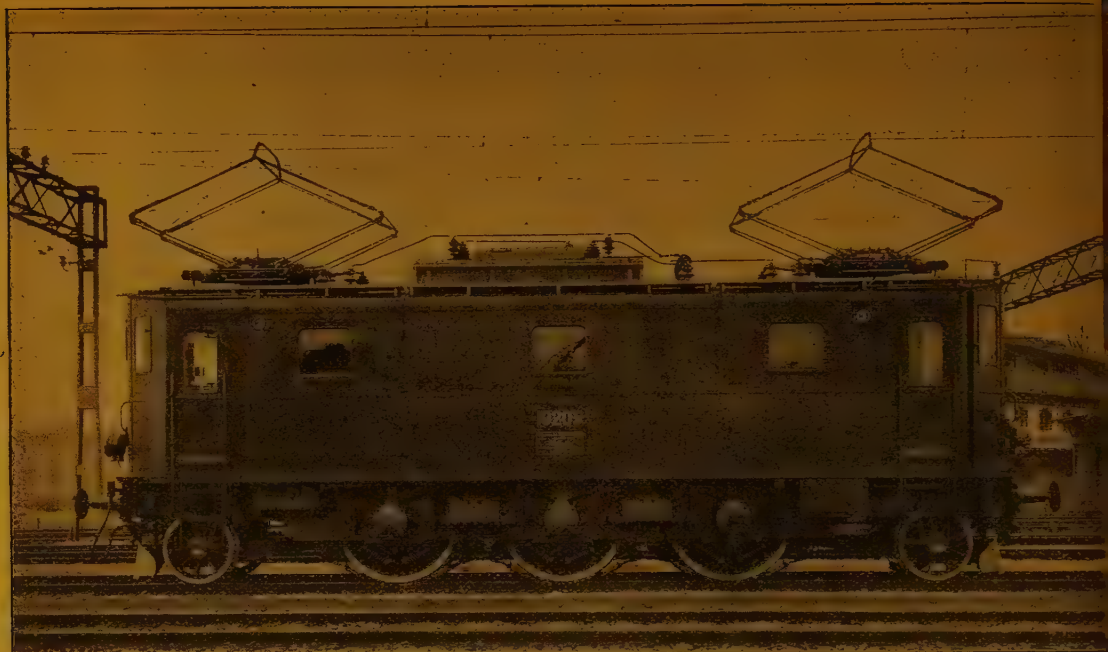


Fig. 15. — Single-phase locomotive, class Ae 3/5 of the C. F. F. (Type 1C1.)

(See table II.)



Fig. 15. — Single-phase locomotive, class Ae 3/61 of the C. F. F. (Type 2C1, No. 10401.)

(See table II.)



Fig. 14. — Single phase locomotive, class Ae 3/6^I of the C. F. F. (Type 2C1, No. 10304.)

(See table II.)

electric braking, are used on the Gothard line, which has heavy and long gradients. The other locomotives are only fitted with Westinghouse and hand brakes.

The transformers on the electric locomotives and automotor vehicles are all fitted with a supplementary collector, capable of supplying 450 kilowatts at 800 to 1 000 volts for the direct electric heat-

ing of the trains. All the passenger carriages are fitted with heaters capable of supplying on an average one kilowatt per ton. The couplings for the electric heating of the coaches and locomotives of the C. F. F. are identical both from the point of view of power and of voltage with the heating couplings adopted by Germany, Austria, Norway, and Sweden.

Table II.

SWISS FEDERATION
ELECTRIC WORKING

Rolling stock (or)

	EXPERIMENTAL						
	LOCOMOTIVES.						
Class	Ae 4/8	Be 2/5	Be 3/5 ¹	Be 4/6 ¹	Be 4/6 ¹	Ce 4/4 ¹	Ce 4/4 ¹
Numbers	11000	11 001	11201	12301	12302	13501-02	14001
Number ordered	1	1	1	1	1	2	2
Number of driving axles	4	2	3	4	4	4	4
Number of carrying axles	4	3	2	2	2	...	...
Arrangement of axles; type	1B1+1B1	1B2	1C1	1BB1	1BB1	BB	C
Total weight, metric tons.	126.8	74.9	90.9	107.2	107.1	39.9-42.5	100
Adhesive weight, metric tons	72.9	33.2	58.5	78.4	75.6	39.9-42.5	100
Weight of electric equipment, metric tons.	55.1	about 33.5	44.1	52.0	49.8	19.0	about 19.0
Average load per driving axle, metric tons.	18.2	16.6	19.5	19.6	18.9	10.0-10.6	17
Length over buffers, in feet and inches	68' 11"	43' 5"	44' 3 1/2"	53' 2"	54' 2"	31' 2"	48
Total wheel-base, in feet and inches	55' 9 1/4"	30' 2"	32' 9 3/4"	43' 3 3/4"	44' 3 1/2"	20' 8"	35' 1"
Diameter of driving wheels, in feet and inches	5' 3 3/8"	5' 3 3/8"	4' 5 1/8"	4' 5 1/8"	4' 5 1/8"	3' 5 3/8"	3' 7"
Diameter of carrying wheels, in feet and inches	3' 5/8"	2' 9 1/2"	3' 5/8"	3' 5/8"	3' 5/8"	...	...
Type of motors	Single						
Voltage of motors, 4/5ths of the maximum transformer voltage, volts.	305	500	400	480	500	275	220
Power developed for one hour at the wheel tread, metric H. P.	2 520	1 000	1 600	2 320	1 920	350	1
Tractive effort for one hour at the wheel tread, in lb.	24 590	9 920	18 960	23 370	22 490	5 950	25
Speed, miles per hour.	38	37.3	31	36.7	31.7	24.9	14
Weight per metric H. P. on the hour rating (of the electric gear), in lb.	...	...	...	...	...	...	...
Number of motors	4	2	2	4	4	2	...
Drive of driving axles.	individually by gearing.	individually by gearing.	by gear and coupling rods.	by gear and coupling rods.	by gear and coupling rods.	by gear and coupling rods.	coupling rods.
Ratio of transmission in motor drive	Tschanz 1:2.58 BBC 1:2.57	Tschanz 1:4.15 BBC 1:2.83	1:2.84	1:3.47	1:2.75	1:3.08	1
Method of controlling the motors	By varying the						
Maximum speed, miles per hour	56	46.6	46.6	46.6	46.6	37.3	37
Method of taking current { by pantograph collector { with pneumatic control.	2	2	2	2	2	1	...
Number of transformers	1	1	2	1	1	2	...
Transformer cooling	by oil.	by air.	by air.	by oil.	by oil.	by air.	by
<i>Braking arrangement.</i>							
(All the locomotives are fitted with the Westinghouse brake and a hand brake.)							
The following locomotives are in addition fitted with the electric brake	Braking on resistances.	...	...	...	...	...	Westing

RAILWAYS.
SINGLE-PHASE CURRENT.

Table II.

(to the end of March 1924).

COMOTIVES.		LOCOMOTIVES.										AUTOMOTOR VEHICLES.
	Automotor vehicles.											
Ce 6/3I	Ce 4/4	Ae 3/5I	Ae 3/6I	Ae 3/6I	Be 4/6I	Be 4/6I	Be 4/7I	Ce 6/8II	Ee 3/4	Ce 4/6		
14201	9701-02	10201-27	10301-46	10401-50	12303-12	12313-42	12501-06	14251-83	16301-02	9801-12		
1	2	27	46	50	10	30	6	33	2	12		
6	4	3	3	3	4	4	4	6	3	4		
2	...	2	3	3	2	2	3	2	1	2		
1CC1	2 × B	1C1	2C1	2C1	1BB1	1BB1	1B1+B1	1CC1	1C	2 × A1A		
125.2	60.0	81.1	92.3	98.5	106.5	111.4	110.5	128.0	48.8	85.3		
105.8	60.0	55.5	55.3	55.3	76.8	80.2	73.9	103.9	39.8	58.2		
out 55.6	24.0	41.6	42.1	43.1	47.2	49.9	55.5	55.0	19.4	26.0		
17.65	15.0	18.5	18.4	18.4	19.2	20.1	18.5	17.3	13.3	14.6		
3' 1 1/2"	57' 5"	40' 2 5/8"	48' 3"	46' 2 3/4"	54' 2"	54' 2"	53' 3 1/8"	63' 8"	32' 2 5/8"	65' 7 1/2"		
115/8"	44' 3 1/2"	30' 6"	35' 1 1/4"	35' 5 1/4"	44' 3 1/2"	44' 3 1/2"	44' 9"	54' 2"	19' 3 1/2"	52' 6"		
4' 5/8"	3' 5"	5' 3 3/8"	5' 3 3/8"	5' 3 3/8"	5' 1/4"	5' 1/4"	5' 3 3/8"	4' 5 1/8"	3' 5"	3' 5"		
2' 9 1/2"	...	3' 5/8"	3' 5/8"	3' 5/8"	3' 5/8"	3' 5/8"	3' 5/8"	3' 5/8"	2' 9 1/2"	2' 9 1/2"		
ies, S. A. 1												
505	247	660	505	380	505	505	660	400	505	247		
2 240	500	1 800	1 890	2 000	1 760	2 040	2 400	2 240	620	780		
32 400	6 610	16 980	18 400	18 300	20 170	23 370	25 350	37 030	12 680	9 700		
25.9	28	39.1	37.9	40.4	32.3	32.3	34.8	22.4	18	29.8		
...	...	...	...	...	...	...	...	...	...	...		
4	4	3 (twin)	3	2	4	4	4 (twin)	4	1	4		
by gear and coupling rods.	individually by gearing	individually by gearing.	individually by gearing.	by gear and coupling rods.	by gear and coupling rods.	by gear and coupling rods.	individually by gearing	by gear and coupling rods.	by gear and coupling rods.	individually by gearing.		
1 : 3.24	1 : 3.15	1 : 5	1 : 2.57	1 : 2.224	1 : 3.5	1 : 3.195	1 : 5.7	1 : 4.03	1 : 3.75	1 : 3.65		
the terminals.												
40.4	46.6	56	56	56	46.6	46.6	46.6	40.4	24.9	46.6		
2	2	2	2	2	2	2	2	2	one to two collectors.	2		
1	1	1	1	1	1	1	1	1	1	1		
by oil.	by oil.	by oil.	by oil.	by oil.	by oil.	by oil.	by oil.	by oil.	by oil.	by oil.		
and hand brake.												
Regeneration	...	...	...	10 401 : with regeneration	...	Braking on resistances.	Braking on resistances.	Regeneration.	...	...		



Fig. 16. — Single-phase locomotive, class Be 4/6 of the C. F. F. (Type 1B61, No. 12541.)
(See table II.)



Fig. 17. — Single-phase locomotive, class Ce 6/8II of the C. F. F. (Type 1CC1, No. 14260.)
(See table II.)



Fig. 48. — Single-phase locomotive, class Be 4/7 of the C. F. F. (Type 4B1M1.)

(See table II.)



Fig. 49. — Single-phase automotor vehicle, class Ce 46 of the C. F. F. (Type 2 × AIA.)

(See table II.)

CHAPTER V.

Some results of working.

A. — Power consumed in traction.

During the first six months from January to May 1921, the Ritom generating station was only supplying the Erstfeld-Biasca section (56 miles) with current at 7 500 volts, supplied direct to the contact wire without the intervention of any sub-station. The total kilowatt-hours used were 7 954 000, measured at 7 500 volts at the generating station of Ritom, for a traffic of 109 256 700 English ton-miles (locomotives included). The consumption of power it will be seen was 73 watt-hours per ton-mile.

During the months from June to December 1921, after the permanent introduction of the standard voltage of 15 000 volts on the contact wire, the same generating station at Ritom supplied the Erstfeld-Bellinzona section (68.3 miles), either direct to the contact wire or through the Göschenen sub-station situated 14.3 miles from the generating station; with a total amount of 11 665 000 kilowatt-hours measured across the bus-bars at 15 000 volts in the Ritom generating station, for a traffic amounting to 191 444 750 English ton-miles (locomotives included). The consumption of power thus amounted to 61.1 watt-hours per ton-mile.

The power supplied by the Ritom generating station in 1922 for the electric working of the Chiasso-Lucerne; Goldau-Zoug, Immensee-Rothkreuz and Lucerne-Zoug lines, having a total length of 238 miles, utilizing the five sub-stations at Melide, Giubisaco, Giornico, Göschenen, and Eteinen, connected to the Ritom generating station by transmission lines having a length of 99.4 miles, amounted

to 42 213 000 kilowatt-hours measured across the bus-bars at 15 000 volts (consequently prior to transformation up to 60 000 volts) in the Ritom generating station, for a traffic amounting to 722 248 225 English ton-miles (locomotives included). The consumption thus amounted to 58.5 watt-hours per ton-mile.

The two generating stations of Ritom and Amsteg working in parallel supplied, in 1923, for working the same lines as above, and one from Zoug to Zurich (a total of 256 miles) using the same sub-stations and that of Sihlbrugg, having 122.4 miles of transmission line, an amount of 63 904 300 kilowatt-hours, measured across the bus-bars at 15 000 volts at the two generating stations, for a traffic of 1 026 482 000 English ton-miles (locomotives included). The consumption of power was therefore 62.6 watt-hours per ton-mile.

To make the matter perfectly clear, it should be noted that all the quantities of power mentioned above deal only with the power consumed by the electric locomotives and automotor vehicles for traction and (since 1923) for heating the trains; they do not include the power supplied for the internal service ⁽¹⁾ of the sub-stations and of the other services of the C. F. F.

(1) The internal service includes the shops, oil purifiers, the working of the cranes, pumping the cooling water, and the electric heating, of the sub-stations, for which, during the whole year of 1923, the consumption averaged 160 000 kilowatt-hours per sub station. For various reasons it is expected that this consumption may be reduced by at least one-half in the future.

According to check measurements carried out over a period of seven months in the year 1923 of the loss of power between the bus-bars at 15 000 volts at the generating stations, and the bus-bar at 15 000 volts at the sub-stations, — losses which consequently include a double transformer loss of 15 000 volts up to 60 000 volts, and of 60 000 volts down to 15 000 volts, as well as the transmission loss — the losses amount on an average very closely to 10 % of the power measured at the generating station. The consumption of power, which was 62.6 watt-hours per ton-mile in 1923, measured across the bus-bars at 15 000 volts at the generating stations, is consequently only 56.4 watt-hours per ton-mile at the 15 000 volt bus-bars at the sub-stations.

The small increase in power consumption per ton-mile in 1923 is doubtless due to the electric heating of the trains from the locomotive; heating which was only introduced during the last year on all the stopping trains not containing foreign rolling stock. The consumption of power for direct heating by means of heaters arranged in the cars, amounts in cold weather to 190-210 watt-hours per axle-mile; the power being measured at 1 000 volts on the locomotive. Steam heating produced in the cars by means of electrodes, has been abandoned after trials in

which it was found that the power consumption amounted to nearly three times as much as that absorbed in direct heating.

It is necessary to add the further detail that through trains containing foreign passenger rolling stock are heated by steam by means of heating cars using coal, coupled up with the train.

* * *

Electric traction on the C. F. F. railway system has so far given complete satisfaction. It would, however, be premature to take the figures obtained so far from the results of working as final, based on so short a period of time, because these results, cannot yet be considered as absolutely definite particularly in view of the fact that the electrification is actually in process of great development, and cannot show yet to the fullest advantage.

One point is certain, and that is that electrification has found much favour with the Swiss, who have not yet entirely forgotten the severe restrictions imposed on the use of foreign coal during the war, and the nearly eight-fold rise in prices above those of 1913 which has had to be paid for the fuel that Switzerland cannot produce.

Berne, 28 March 1924.

Automatic coupling and the safety of railway workers ⁽¹⁾,

By EM. UYTBORCK,

HONORARY ENGINEER OF THE BELGIAN STATE RAILWAYS.

The question of automatic coupling has appeared frequently on the agenda of the International Railway Congresses ⁽²⁾. It has for many years engaged the attention of railway engineers, especially from the following points of view: mechanical perfection, safety and the practical aspects of the system as regards both coupling and uncoupling, the cost as compared with that of buffergear and of non-automatic coupling, the cost of transformation and the technical difficulties arising out of the gradual introduction of automatic coupling on a railway system, and, lastly, comparison of the safety of shunting as between a railway system which has, and one which has not, adopted automatic coupling.

The International Labour Bureau has recently published a very interesting report on the statistics relating to accidents which have occurred during the coupling or uncoupling of wagons and carriages. This report is entitled: « L'attelage automatique et la sécurité des travailleurs des chemins de fer » (« Automatic coupling and the safety of railway workers ») (International Labour Bureau, Research and Documents, Series Fbis, « Safety », No. 1, Geneva, 1924).

It is not surprising that the Administrative Council of the International Labour Bureau should have approved the compilation of statistical data in regard

to the safety afforded by automatic coupling. The risks run by railway workers whose duty it is to couple and uncouple carriages and wagons are generally recognised as particularly serious. The report in question contains a wealth of information collected from various sources, and we think it will be useful to our readers if we summarise it by reproducing the more interesting passages and tables.

As stated in the introduction to the report, it was on the 29 October 1923, in the course of the fifth session, and on the motion of the Swiss workman-delegate, M. Charles Schurch, that the International Labour Conference adopted the following resolution:

« The fifth Session of the International Labour Conference, considering the importance of questions connected with the coupling of vehicles in relation to the safety of work on railways, requests the Administrative Council to consult with the various Governments and international technical and professional organisations with reference to the question of automatic coupling, with a view to determining whether it is not desirable in the interests of the workmen to hold an international inquiry into the subject. »

The International Labour Bureau has obtained information from fifteen countries, viz., Germany, Austria-Hungary (former Empire), Belgium, Canada, United States, Finland, France, India, Luxembourg, Norway, Holland, Roumania, United Kingdom, Sweden, Switzerland.

⁽¹⁾ Translated from the French.

⁽²⁾ See *Bulletin of the International Railway Congress*, July 1900, p. 2175; July 1900, p. 2149; November 1900, p. 3569; July 1904, p. 547; January 1905, p. 173; January 1905, p. 287.

After examining in some detail the historical side of the question and quoting various opinions, referring in particular to the proceedings of the International Railway Congress held at Washington in 1905, the report confines itself to an analysis of the three following main points :

1° The percentage of accidents due to coupling and uncoupling as compared with the total number of accidents to railway employees;

2° The ratio of accidents per thousand railway employees;

3° The ratio of accidents per million train-kilometres or engine-kilometres.

When examining the statistics furnished by the United States, the authors of the report are careful to mention that the coupling device used in the past in that country, known as the « Link and Pin Coupling », was extremely dangerous. This assertion is supported by the remarkable data given in tables I, II, III and IV.

TABLE I. — Percentage of accidents due to coupling and uncoupling of total number of accidents to railway employees.

YEARS.	Fatal.	Non-fatal.
1893.	15.88	35.54
1902.	4.82	4.18
1907.	6.59	4.50
1914.	5.24	1.63
1905-14 (average) .	6.27	2.87

TABLE II. — Number of accidents per thousand couplings and uncouplings carried out by drivers, firemen, guards and train crew.

YEARS.	Fatal.	Non-fatal.
1893.	2.41	62.77
1902.	0.63	9.37
1907.	1.01	13.37

TABLE III.
Number of accidents per 1 000 employees.

YEARS.	Accidents of all kinds.		Accidents in coupling and uncoupling.	
	Fatal.	Non-fatal.	Fatal.	Non-fatal.
1893.	3.12	36.31	0.50	12.90
1902.	1.78	42.48	0.12	2.50
1907.	2.71	52.42	0.18	2.36
1914.	1.87	94.93	0.10	1.55
1905-14 (average).	2.07	66.55	0.14	1.91

TABLE IV.
Number of accidents per million train-miles (1).

YEARS.	Accidents of all kinds.		Accidents in coupling and uncoupling.	
	Fatal.	Non-fatal.	Fatal.	Non-fatal.
1893.	3.23	37.54	0.51	13.34
1902.	3.28	55.77	0.16	2.33
1907.	3.98	76.95	0.26	3.46
1914.	2.62	133.10	0.14	2.17
1905-14 (average).	3.04	93.23	0.19	3.04

The statistics relating to Canada are much less significant and less interesting than those for the United States. As a matter of fact, there are no Canadian statistics in respect of the period prior to the adoption of automatic coupling. The figures in tables V, VI and VII relating to Canada leave us in some doubt as to the increase of safety due to the substitution of automatic coupling for hand coupling.

(1) 1 mile = 1 609 metres.

TABLE V. — Percentage of accidents in coupling and uncoupling compared with total number of accidents.

YEARS.	Fatal.	Non-fatal.
1912	7.7	7.1
1920	7.1	3.1
1912-20 (average).	7.5	3.9

TABLE VI.

Ratio of accidents per thousand employees.

YEARS.	Accidents of all kinds.		Accidents in coupling and uncoupling.	
	Fatal.	Non-fatal.	Fatal.	Non-fatal.
1912	1.50	48.2	0.12	4.33
1920	1.08	49.7	0.08	4.56
1912-20 (average).	1.31	28.9	0.10	4.11

TABLE VII.

Ratio of accidents per million train-miles.

YEARS.	Accidents of all kinds.		Accidents in coupling and uncoupling.	
	Fatal.	Non-fatal.	Fatal.	Non-fatal.
1912	2.32	29.00	0.18	2.06
1920	1.42	65.60	0.10	2.05
1912-20 (average).	1.85	40.55	0.13	1.55

As regards the other countries for which statistics are available relating to accidents, the report has grouped them in the three tables, VIII, IX and X.

TABLE VIII. — Percentage of accidents in coupling and uncoupling in various countries. Compared with total accidents.

COUNTRY.	Period under review.	Fatal accidents.	Non-fatal accidents.
United Kingdom . .	1911-1920	3.27	11.33
India	1919-1920	6.18	11.15
Belgium	1909-1913	8.00	20.81
France	1919-1923	9.76	16.39
Switzerland	1913-1922	11.38	11.70
Luxembourg			
Holland	1905-1909	7.89	14.02
Roumania			
Austria-Hungary . .	1905-1909	14.57	14.69
Germany (1)	1905-1909	15.58	14.26
Sweden	1906-1916	14.18	22.21
Norway	1913-1920	19.22	19.00
Finland	1911-1920	2.63	4.74

(1) Two series of statistics exist for Germany. The statistics for the period 1905-1909 are given as being comparable with the other statistics of the Federation of German Railways.

TABLE IX. — Ratio of accidents per thousand employees in various countries.

COUNTRY (1).	Fatal accidents.		Non-fatal accidents.	
	Accidents of all kinds.	Accidents in coupling and uncoupling.	Accidents of all kinds.	Accidents in coupling and uncoupling.
United Kingdom.	0.62	0.02	8.61	4.02
India	0.71	0.04	4.34	0.15
Belgium	0.17	0.09	8.98	1.29
France	...	...	...	...
Switzerland	0.97	0.11	45.85	5.46
Luxembourg				
Holland	0.99	0.08	2.33	0.26
Roumania				
Germany	0.99	0.15	2.38	0.34
Austria-Hungary	0.70	0.10	5.25	0.77
Sweden	1.00	0.14	5.64	1.25
Norway	0.62	0.12	4.92	0.93
Finland	0.59	0.02	1.78	0.03

(1) The periods under review are the same as in the table of percentages except as regards the figures for the United Kingdom which are in respect of the period 1911-1914.

**TABLE X. — Ratio of accidents
per million train-kilometres in various countries.**

COUNTRY (1)	Fatal accidents.		Non-fatal accidents.	
	Accidents of all kinds.	Accidents in coupling and uncoupling.	Accidents of all kinds.	Accidents in coupling and uncoupling.
United-Kingdom.	0.60	0.02	8.11	0.96
India	1.76	0.41	3.65	0.41
Belgium	0.90	0.07	6.92	1.43
France	...	...	...	...
Switzerland . . .	0.72	0.09	34.17	4.00
Germany	0.98	0.15	2.35	0.33
Luxemburg . . .				
Holland	1.03	0.08	2.41	0.27
Roumania				
Austria-Hungary	0.95	0.14	7.11	1.04
Sweden	0.88	0.13	5.16	1.19
Norway	0.30	0.06	2.38	0.45
Finland	0.76	0.02	2.28	0.04

(1) The periods under review are the same as in the preceding Tables, except in the case of the United Kingdom where the figures given are for the period 1911-1914.

Chapter V of the report, devoted to a comparison of the risks of accident in coupling and uncoupling in America and Europe, states that the risks of accident are not greater in the United Kingdom than in the United States. It is even stated, on the contrary :

Our analysis has shown that in the United Kingdom the risks of accident indicated by the statistics are less than in the United States. Whereas in the United States the percentage of accidents in coupling and uncoupling, as compared with the total number of accidents to employees (average for the period 1905-1914), was 6.3 (fatal accidents) and 2.9 (non-fatal accidents), the corresponding figures for the United Kingdom (average for the period 1911-1920) are 3.3 and 2.5.

It is to be regretted that in the concluding part of this chapter, tables XI, XII and XIII compare only the figures for

Continental Europe with those for North America, the very interesting statistics relating to the United Kingdom being omitted.

TABLE XI.

	Percentage.	
	Fatal accidents.	Non-fatal accidents.
Continental Europe . . .	3-19	2-24
North America (United States and Canada) . .	6-7	3-4

TABLE XII.

	Ratio per thousand accidents.	
	Fatal accidents.	Non-fatal accidents.
Continental Europe . . .	0.02-0.15	0.03-5.46
North America (United States and Canada) . .	0.10-0.14	1.11-1.91

TABLE XIII.

	Ratio per million train-kilometres.	
	Fatal accidents.	Non-fatal accidents.
Continental Europe . . .	0.02-0.18	0.04-4.00
North America (United States and Canada).	0.08-0.09	0.97-1.11

The reader is left with the impression that, even where automatic coupling is not in use, it is possible by good organisation and an intelligent observation of the elementary rules of prudence to reduce the risks of accident to the same level as in countries where automatic coupling is used.

Chapter VI examines the risks incurred by employees engaged in shunting as compared with the risks to which other railway employees are exposed.

Then follows the general conclusion which we reproduce below :

« We have seen that the adoption of automatic coupling has contributed in a large measure to the safety of railway employees. The results obtained in the United States indicate an improvement which can be estimated at from 70 to 80 % as regards fatal accidents, and from 80 to 90 % as regards non-fatal accidents incurred in coupling and uncoupling.

As regards those countries which have not adopted automatic coupling, we have analysed in considerable detail the degree of risk of accident inherent in the prevailing system of coupling and uncoupling. We have noticed that in this connection there is a marked difference between the United Kingdom and Continental Europe. In the former country the risks of accident in coupling and uncoupling (expressed on the one hand as a percentage of the total number of accidents to employees, and on the other hand as ratios based on the total railway personnel and the number of train-kilometres run during the year) appear to be much smaller than those indicated for the United States since the adoption of automatic coupling. On the other hand, in the majority of the countries of Continental Europe the risks of accident

in coupling and uncoupling, as indicated by percentages and ratios, are higher than in either the United Kingdom or the United States.

It is particularly interesting to note, further, from the statistics of the United States and of certain other countries, that the risks incurred by employees in coupling and uncoupling are exceptionally high. It is no exaggeration to estimate these risks, in a general way, at an annual ratio per thousand shunters of from 1.5 to 2.5 killed and from 50 to 60 injured (the number of severely injured being about one-fifth of this number).

It is possible to estimate approximately the number of accidents due to the use of non-automatic coupling system in the eleven European countries dealt with in the present report. If we total in the first place the annual number of fatal accidents given in the annexed Tables, we obtain the figure 225. A corresponding calculation for non-fatal accidents would be valueless because of the variation in the methods of notifying these accidents; but, by utilising the above-mentioned accident ratios as regards men engaged in shunting, we arrive at an approximate figure, varying from 4 500 to 9 000 injured, and from 900 to 1 500 seriously injured.

These figures show how extremely high is the number of railway employees killed or injured each year in the course of coupling and uncoupling operations, in eleven European countries only ».

Generally speaking, it may be mentioned that the report of the International Labour Bureau is, in some respects, somewhat unprecise. For this reason there is some doubt about the comparisons of the number of accidents per thousand couplings and uncouplings; it is only incidentally, as a matter of fact, that one finds in the report the statement that certain figures quoted on this subject refer to shunting operations carried out not by employees of all categories, but merely by the train crews.

However, it must be recognised that in spite of these criticisms, the report by the International Labour Bureau is of great interest.

The Baltimore & Ohio Railroad Company color position light signals,

By F. P. PATENALL,

SIGNAL ENGINEER, BALTIMORE & OHIO RAILROAD COMPANY.

Fig. 1, pp. 1158 and 1159.

Historical.

The use of white and colored lights for night signal indications dates back many years, the instructions transmitted having been found to be readable and understandable and the results obtained cannot be questioned.

The display of both white and colored lights at certain predetermined angularities to the mast for night signaling on some American railroads was found to be expedient in the 80's, as in 1888 it is noted that the Boston & Albany and Old Colony Railroads used the following aspects in connection with their night signaling, *viz* :

Boston & Albany Railroad : Home signals, two white lights in horizontal line, stop;

Distant signals, two green lights in horizontal line, caution;

Home and distant signals, two green lights in vertical line, clear.

Old Colony Railroad : Home signals, two red lights in horizontal line, stop;

Distant signals, two green lights in horizontal line, caution;

Home and distant signals, two white lights in vertical line, clear.

This shows that the theory of producing for night indications a similarity in the positioning and displaying of lights at certain angularities to the mast is logical, in that by day the arms being so

displayed in their various angles to the mast have been read, understood and effectively acted on by enginemen as indicating the various required conditions.

Color night signals.

Since it has been definitely demonstrated after many years of use that at night colored and white lights have satisfactorily provided the means of transmitting various degrees of information and instructions to trainmen, it is safe to assume that a continuation of a system of colored night signals is in line with good practice and can be relied upon as a distinct means of indicating to trainmen what action in the handling of their trains should be taken by them when such indications are displayed.

Colored lights having proved their utility as night signals, there is no good reason why such a system cannot be expanded and use the same colors for daylight service, eliminating the arms and other moving parts, provided sufficient volume and intensity of light is displayed, and if, without any possibility of a doubt, such distinctness in colored lights for daylight signaling is now available, there is no argument against such a system being largely used and standardized and thus produce a means of simplifying the reading of indications as well as to reduce the cost of construction and subsequent maintenance and operation.

**Present system,
combination of arms and colored lights.**

Our present system is such as to require for daylight signaling the use of arms, variably positioned according to track conditions or such other information required to be transmitted to trainmen, *viz*: horizontal, diagonal or vertical.

At night these arms (whilst required to operate in conjunction with the lights displayed), are not of use, as the instructions and information transmitted to trainmen are through the medium of colored lights, *viz*: red, yellow, green:

Red being the equivalent of the arm horizontal;

Yellow being the equivalent of the arm diagonal;

Green being the equivalent of the arm vertical.

It will be recognized at once that these day and night indications differ from each other very materially, in that by day the position of the arm transmits the information, whereas at night the color of the light serves the same purpose. The use of both consequently is not such as to simplify the language of signals but instead complicates it.

The present combination system of using arms by day and lights by night requires the memorizing of innumerable aspects. One red light, or two, or three red lights in vertical line now constitute the night stop indication, whereas by day, such arms are displayed horizontally for the stop indication, hence a variance which is not consistent, and whilst it is thoroughly understood, does not by any means prove its correctness.

Then again in certain instances the same position of arm and color of light are used to indicate two different conditions, which whilst permissible, cannot be accepted as the best practice and these

differences and discrepancies are corrected and the requirements fully covered in the new system of color position light signals.

Under the present system we have no distinctive permissive indication, as in the use of the ordinary manual block signal, the arm at 45°, the same color light (yellow) is displayed, indicating « Proceed, block occupied » as is displayed in automatic block signal territory indicating: « Prepare to stop at next signal »; hence, there is here room for improvement, and it will be seen that the color position light signal can be made to more clearly define the action required under the respective indications displayed.

**Proposed system, color position
light signals for both day and night use.**

There seems to be no doubt but that the use of colored lights for night signaling has successfully and safely met the requirements; they are now used and will continue as standard practice for many years, their efficiency, therefore, needs no further substantiation. This being the case, and seeing that we are now able to apply a system of distinct readable colored light aspects for daylight signaling, there is no valid reason why we should continue to install complicated mechanisms, either mechanical or electrical, for the purpose of moving signal arms to predetermined positions now required.

The colored lights in the proposed system will be the same as those used in the present system, *viz*: red, yellow, green, with the addition of lunar white, (a new distinct color signal), proposed to be used in permissive operation for slow speed movements, thus assigning and holding for the three primary needs the three colors first mentioned and now used.

Granted that arms displayed at various

Routes.	All routes.	Main route.					Restricted route.
Day and night aspects.							
Indication.	Stop.	Stop then proceed.	Proceed prepared to stop short of train or obstruction.	Proceed prepared to stop at next signal.	Proceed, approach next signal at restricted speed.	Proceed.	Stop then proceed.
Name.	Stop signal.	Stop and proceed signal.	Permissive signal.	Approach signal.	Approach restricting signal.	Clear signal.	Stop and proceed signal.

Fig. 1. — Baltimore & Ohio Railroad.

angles properly transmit the desired information to trainmen, it being conceded that present practice in day signaling is good, distinct and understandable, it is, therefore, logical to assume that to display these indications by means of the various

angularities of lights is following along the lines of good practice.

With this as a basis, the following angularities of lights can readily be accepted as better filling our needs, both for day and night signaling, viz :

Two red lights in horizontal line.	Stop.
Two lunar white lights in diagonal line in the lower-quadrant.	Proceed at slow speed. Permissive.
Two yellow lights in diagonal line in the upper-quadrant	Proceed, prepared to stop at next signal.
Two green lights in vertical line	Proceed.
White marker light above two red lights in horizontal line	Stop then proceed. Main route.

Restricted route.				Slow route.		
Proceed prepared to stop short of train or obstruction.	Proceed prepared to stop at next signal.	Proceed, approach next signal at restricted speed.	Proceed.	Proceed prepared to stop short of train or obstruction.	Proceed prepared to stop at next signal.	Proceed.
Permissive signal.	Approach signal.	Approach restricting signal.	Clear signal.	Permissive signal.	Approach signal.	Clear signal.

Standard color position light signals.

White marker light below two red lights in horizontal line Stop then proceed. Restricted route.

In connection with the two latter aspects and indications, trains after stopping are allowed to proceed under the rules at slow speed expecting to find either a broken rail, a train, a switch open, or other obstructions in the block.

With the exception of the additional color « lunar white », it is observed that the same three (3) primary colors for the purposes required are proposed to be used as is now our practice, hence the

ease with which such aspects and indications can be read and understood by trainmen is apparent.

The proposed system it is seen utilizes five (5) colors and four (4) positions to meet the six (6) requirements under the rules, and which cannot be distinctly and properly accomplished otherwise.

Current for position color light signals can be obtained either by the use of battery or from a power source, and their

operation and selection is through the medium of relays and circuit controllers as between the lights and the levers, and track conditions affecting them. The principle involved is that of causing the lights to be extinguished or lighted as the route or block conditions, or both, may require. In brief, instead of applying mechanisms with their connections and intricate gearings and parts, lights are used both for day and night signaling.

Rules, aspects and indications.

From a study of the proposed rules, aspects and indications in comparison with those now our standard, it must be concluded that the new system with its 14 aspects in its entirety is much simpler than the present system with its 135 aspects as shown in the rules. The underlying color principles of present night signaling is not set aside and this renders it much easier to commit to memory where changing from the old to the new system. A runner having absorbed mentally the present night light indications will find no difficulty in assimilating himself to reading the same colors in daylight.

Then again, the angular positioning of the lights is an added factor of distinctness, four (4) angles of lights being provided for the four (4) primary conditions to be met, and which aside from color lends itself to a more conspicuous display of the indications.

The basic arguments in favor of the proposed system are :

1° The day and night indications are the same;

2° With aspects indicating proceed at slow speed; proceed at restricted speed, or proceed, no red lights are displayed;

therefore, this obviates the necessity of disregarding a stop indication as displaying in conjunction with a proceed indication in our present practice;

3° Instead of trainmen being required to memorize 135 diagrams and 34 rules, they will only be required to commit to mind 14 aspects and 6 rules;

4° White upper and lower route markers for high speed and restricted speed routes respectively, indicate clearly which route is set, in conjunction with the block indications displayed.

5° Reduction in the cost of construction, maintenance and operation.

It might here be remarked that position as well as color light signals whilst in our opinion best, do not bind us to the hard and fast rule that color without position cannot be used, because we have demonstrated during fifty years of practice that color alone has reasonably well functioned as the night signal indication, although the angular positioning of such colored lights makes the indications much more conspicuous and definite.

By reason of the required closer spacing of signals in some parts of the territory which naturally shortens up the braking distances between signals, this signal system provides the means of expansion whereby through aspects Nos. 5 or 10 restrictive indications are displayed at the second signal in the rear of the stop signal, and it will be seen, therefore, that by the use of such indications enginemen will be notified in ample time before reaching a stop signal. Our present signals indicate but two blocks and do not provide this information, and of course where signals are spaced further apart it will not be necessary to use these two particular indications for the purpose outlined.

The sorbitic treatment of rails, ⁽¹⁾

By CECIL J. ALLEN.

Figs. 1 to 4, pp. 1163 to 1168.

(*Railway Review.*)

Sandberg sorbitic treatment for rails, is carried out at the Cleveland works of Bolckow, Vaughan & Co., Ltd., by methods devised and patented by the well-known London consulting engineers, Messrs. C. P. Sandberg, and under the immediate supervision of the latter. Detailed views are reproduced herewith, the first showing a rail just skidded up to the girder, and the second the rail raised and in position for treatment. Before the working of the plant is described, the principles underlying the treatment which are among the most interesting of those put into application at the Cleveland Works, may briefly be explained. It is a commonly known fact that steel is remarkable for the wide variations in the physical properties that may be secured as a result of variations of both its content of carbon and also the heat treatment to which it is subjected. Increased carbon percentages give increased hardness coupled with reduced ductility and resistance to shock, and in the case of rail steel the point is reached at round about, say 0.70 % carbon, when this limited resistance to shock becomes a risk too serious to be entertained. By suitable heat treatment the normal hardness of medium and high carbon steels can be greatly increased, or, at will, appreciably reduced, so that heat treatment places at the disposal of the user a wide

range of variability in tenacity, ductility and hardness for any one given carbon percentage rather than by a variation of the percentage itself in order to attain the desired result. The range of physical properties obtained by variations in the heat treatment of steel is, indeed, greater than that obtainable by variation of carbon content.

The characteristic of sorbite.

Steel is crystalline in its structure, the amount of carbon present influencing the nature and composition of its crystals, while the heating of the steel and the rate of its subsequent cooling determine its final crystalline structure. Over-heating results in a coarse structure, while by the combination of work on the steel and a suitable heat treatment a very fine grain may be obtained. In normally cooled steels the iron, or ferrite, and the iron carbide, or cementite (which is a chemical combination of the carbon present with a certain proportion of the iron), crystallize in alternate layers, making a structure known as pearlite, while any excess of iron left over from the above distribution crystallizes around the pearlite, and is known as free ferrite. In high carbon steels, such as tool steel, it is the iron carbide which is in excess, and the latter, distri-

(¹) This article is abstracted from one of a series appearing in the *Railway Engineer*.

buted in the same way as the free ferrite just referred to, is known as free cementite. If the steel be heated up to a point above the « critical temperature », which may be taken as about 720° to 750° C. in the case of rail steel, the ferrite and the cementite pass into a condition which is known as a « solid solution », and a gradual cooling down again will permit a re-crystallization to the original pearlite condition of the steel. But if the cooling be accelerated, it is possible to arrest the crystallization at stages which completely alter the physical properties of the steel. If the steel be quenched right out in cold water from above the critical range, the condition of solid solution is retained, the structure is known as martensite, and is glass hard and exceedingly brittle. Rather less violent quenching allows of a partial re-crystallization to the structure known as troostite, which is not so hard or brittle as martensite. The next lower range is sorbite, in which the steel is at its maximum combination of hardness and toughness, and this is the range aimed at in the heat treatment of steels likely to be subjected to exceptional wear or shock. The pearlitic or completely re-crystallized condition gives the maximum combination of softness and ductility.

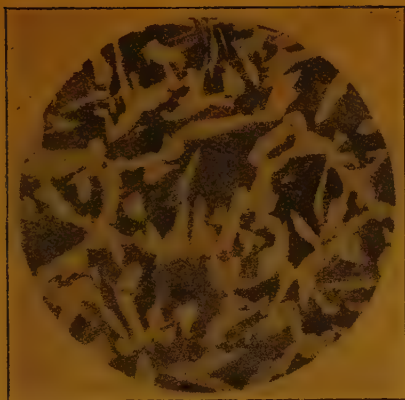
Problems of treatment on a large scale.

This is an inadequate exposition of what is in reality a subject of extreme complexity, but it may be sufficient to explain the object of the Sandberg sorbitic process, which is designed to take the rails as they come from the mill, still at a temperature well above the critical range, and then to cool the rail-heads through such a range of temperature and at such a speed as shall arrest and hold the crystalline structure at the exact point at which the sorbitic structure is attained. It has been customary for years past to heat treat gun and other special forgings with the same object in

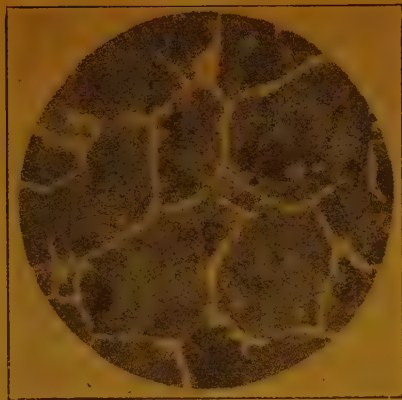
view, but the individual treatment when it is realized to what fine cooling rate limits of costly forgings is obviously a problem different altogether from the routine treatment of from 50 to 100 % of a rolling of steel rails, which are brought to the apparatus at a frequency from 30 up to 60 or even more per hour. The difficulty of the problem is emphasized when it is understood the process must be worked in order to avoid extreme hardening on the one hand or insufficient on the other, and thus to obtain the combined hardness and toughness which is characteristic of the sorbitic structure. The actual method has been the fruit of exhaustive experiments both at the Cleveland Works and elsewhere, and that it has been brought to so notable a success commercially as is apparent in the test results which follow is a matter that is to the credit both of the inventors and manufacturer.

Method of treating rails

The appliances are carried on the girder which is seen spanning the rail hot-bank in the illustrations. This is a box girder in design, divided into two compartments longitudinally, one of which acts as a reservoir for water, and the other for compressed air at a pressure of between 3/4 lb. and 1 lb. per square inch. The pressure is supplied by a motor driven fan located at one end of the girder. Underneath the girder are seen a number of vertical legs, provided with feet; these feet intercept the rails to be treated, as the latter are being skidded across the hot-bank from the mill roller train. The legs are hydraulically operated, and lift the rail, head upwards, towards the girder, the exact height being controlled in accordance with the depth of the rail under treatment. From a series of patent nozzles arranged 2 1/2 inches apart a blast of cold air is then directed onto the head of the rail throughout its length, the



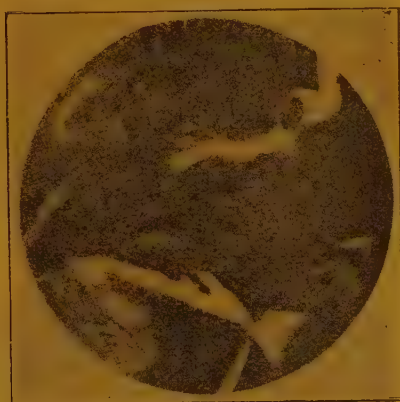
0.56 % carbon steel rail, untreated.
($\times 1\,000$ diameters).



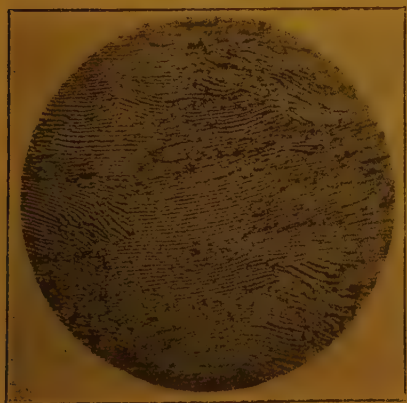
0.56 % carbon steel rail, sorbitically treated.
($\times 1\,000$ diameters).



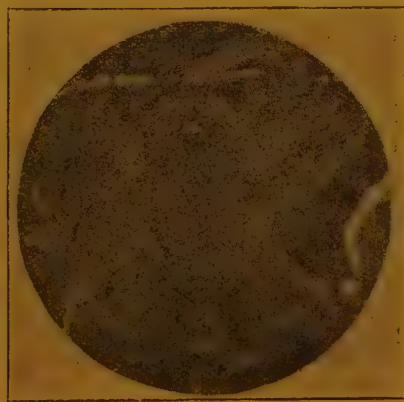
0.56 % carbon steel rail, untreated.
($\times 250$ diameters).



0.56 % steel rail sorbitically treated.
($\times 250$ diameters).



0.73 % carbon steel wheel tire, normal.
($\times 1\,000$ diameters).



0.73 % carbon steel tire, sorbitically treated.
($\times 1\,000$ diameters).



Fig. 2. — The rail ready to be lifted for sorbitic treatment.



Fig. 3. — The rail lifted and under treatment, Sandberg sorbitic process.

cooling effect of which is augmented by a spray of very finely atomized water; the atomization is effected by the action of the compressed air on a water jet of 1/16 inch diameter, so that the amount of water actually used is exceedingly small. The nozzles are so arranged that the cooling effect is evenly distributed over the whole of the rail head. The actual cooling period varies according to the cross sectional area of the rail head and the temperature at which the treatment of the rail is commenced; and any rail which, through delay in the rolling or other causes, may arrive at the girder below the minimum practicable commencing temperature, which is about 770° to 780° C., or slightly above the critical range, can be skidded along the hot bank past the girder as an untreated rail, the hydraulic lifting legs being raised to permit the rail to pass underneath. It has been found at the Cleveland Works that a single sorbitic treatment plant is capable of treating one-half the rail mill output; if and when it is desired to treat the full output, this can be achieved without difficulty by installing a second treating plant alongside the first, so that two rails may be dealt with simultaneously. The actual time of treatment is the controlling factor, and at present, when treatment is being carried out, one half of the rails rolled are skidded past the girder as untreated, while the other half are raised by the lifting arms and are undergoing treatment.

Tests carried out.

The results which follow are tabulated on the same lines as those on ordinary basic open hearth rails. They are obtained on a rolling of 2 200 tons of the 100-lb. per yard flat bottomed rail section, a diagram of which is shown, executed recently by Bolckow, Vaughan & Co. for an important railway overseas. Of this total one half of the rails were sorbitically treated. In regard to testing, a falling weight test was made on a treated rail and an untreated rail out of every heat; the specified test was that a 5-foot piece supported on 3-ft. 6-in. centers should sustain without fracture a single blow from a 1-ton tup falling from 22 ft. 6 in. In addition to this, impression tests were taken on treated and untreated rails out of each heat; these were made on the head of the rails in a 100-ton Buckton machine by the imposition of a 50-ton load through the medium of a hardened 19 mm. ball, the depth of the impressions being measured micrometrically. Brinell tests on polished cross sections of rails, and tensile tests, were also taken at frequent intervals. Each pair of tests, treated and untreated, was made on two rails out of the same ingot.

Test results on treated and untreated rails.

The average results attained on a total of 50 heats, were as follows :

Analysis :	Carbon.
Average of 50 heats.	0.64
Falling weight test :	
Average of 50 heats	
Impression test :	
Average of 50 heats	
Brinell test :	
Average Brinell number, positions 1-5 shown in diagram	

Silicon.	Sulphur.	Phosphorus.	Manganese.
0.11	0.039	0.033	0.795
<u>Deflections under 1-ton tup at 22 ft. 6 in.</u>			
Untreated.	Treated.		
2.25 inches.	1.94 inches.		
<u>Impressions of 19 mm. ball under 50-ton load.</u>			
Untreated.	Treated.		
3.4 mm.	2.5 mm.		
<u>Impressions of 10-mm. ball under 3 000 kgr.</u>			
Untreated.	Treated.		
231	296		

Tensile test :	Breaking stress.	Elongation in 2 inches.	Reduction of area.
Average of 15 tests :	Tons sq. in.	Per cent.	Per cent.
Untreated	55.1	16.0	25.8
Treated	65.7	12.4	23.6

It will be seen from this table that the percentages of both carbon and manganese were slightly higher than in the average analysis, but it is even more confirmatory of the exceptional ductility of basic open-hearth steel that an average elongation as high as 16 % was reached in the case of the untreated rails with an average tonnage of 55.1. The effect of the sorbitic treatment was to raise the tonnage by 10.6 to 65.7 tons per square inch, while at the same time the average elongation percentage did not fall below 12.4, which is well above the minimum of 10 %, demanded by the British standard specification, with a maximum tonnage of 55 only. The average Brinell number was raised by no less than 65 points from 231 to 296. The

complete absence of brittleness in the treated rails, is proven by the fact that not one of the treated test pieces failed under the falling weight test throughout the contract, and in many cases blows from 22 ft. 6 in. additional to the one specified were sustained without fracture of the rails.

Some exceptional test results.

As illustrating the possibilities of the Sandberg sorbitic treatment, the following table shows the results of analyses, falling weight, tensile, impression and Brinell tests on the six most notable samples of treated steel observed during the carrying out of this contract:

ANALYSIS.

Heat No. :	2	3	5	23	27	42
Carbon	0.630	0.680	0.680	0.620	0.660	0.630
Silicon	0.130	0.120	0.120	0.130	0.140	0.100
Sulphur.	0.034	0.040	0.049	0.038	0.042	0.045
Phosphorus.	0.031	0.038	0.038	0.029	0.039	0.029
Manganese	0.780	0.850	0.800	0.820	0.800	0.780

Falling weight test deflections in inches.

First blow at 22 ft. 6 in. :

Untreated	2.25	2.00	2.06	2.31	2.06	2.25
Treated	1.88	1.69	1.69	1.94	1.75	1.87

Second blow at 22 ft. 6 in. :

Untreated	4.19	3.69	...	...	...	4.06
Treated	3.56	3.19	...	...	3.19	3.50

Third blow at 22 ft. 6 in. :

Untreated	6.13	5.50	...	...	...	...
Treated	5.38	4.69	...	...	...	...

Tensile test.

Breaking stress, in tons per square inch :

Untreated	54.8	58.8	56.8	51.2	54.8	54.4
Treated	68.8	70.0	73.2	62.8	66.4	67.6
Rise due to treatment	14.0	11.2	16.4	11.6	11.6	13.2

Elongation in 2 inches, per cent :

Untreated	17.0	16.0	13.0	16.0	17.0	16.0
Treated	10.0	10.5	8.0	17.0	13.0	10.0

Reduction of area, per cent :

Untreated	30.8	30.8	18.4	27.6	24.8	24.8
Treated	18.4	24.8	16.8	30.8	24.8	18.4

Impression test (500 tons on 19 mm. ball).

Depth of impression, in millimetres :

Untreated	3.5	3.2	3.2	3.7	3.4	3.6
Treated	2.5	2.3	2.2	2.6	2.3	2.8

Brinell hardness numbers (positions shown in diagram).

Position 1 :

Untreated	223	241	217	217	235	223
Treated	277	302	277	286	286	293

Position 2 :

Untreated	223	241	223	217	241	223
Treated	286	321	302	286	302	302

Position 3 :

Untreated	223	241	241	217	228	223
Treated	290	302	302	277	302	286

Position 4 :

Untreated	223	241	241	223	241	228
Treated	286	302	302	293	286	302

Position 5 :

Untreated	223	235	241	228	248	228
Treated	293	302	311	286	302	302

Position 6 :

Untreated	217	241	228	228	248	223
Treated	241	286	277	286	255	269

Position 7 :

Untreated	217	228	255	228	241	228
Treated	255	269	277	255	286	269

Position 8 :

Untreated	217	228	255	228	255	228
Treated	235	277	293	269	269	255

Position 9 :

Untreated	223	233	255	228	286	228
Treated	217	228	253	241	228	241

Position 10 :

Untreated	228	241	248	217	262	228
Treated	228	241	253	228	241	241

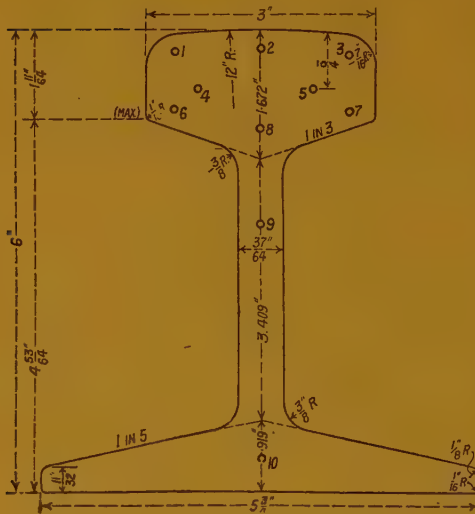


Fig. 4. — Section 100-lb rail, showing location of impressions in the Brinell test.

Taking the Brinell tests first, we see that the effect of the sorbitising treatment extends well down through the head, fairly uniform readings being obtained on the treated rail sections in positions 1 to 5 inclusive, while the average of positions 6, 7 and 8 is very nearly as high. That is to say, practically the whole of the head of the rail is changed from the pearlitic to the sorbitic structure. The high Brinell figure obtained in the web and center of the foot in the case of the untreated rail of heat 27 was probably due to some slight segregation of carbon. Excellent tensile test results were obtained. The average of the six

tests on untreated rails corresponds almost exactly with the general average for the rolling; the result of treatment was to raise this average from 55.1 to 68.1 tons per square inch, or by 13.0 tons, while the percentage of elongation was reduced from an average of 15.8 % to one of 11.4 %. It was only within the exceedingly high stress of 73.2 tons per square inch that the elongation percentage fell below 10 %.

Microstructure of sorbite.

Such results as the foregoing should be amply sufficient to prove, not only that materially increased hardness is secured, for that portion of rail subject to wear, by the sorbitic treatment, but also that this hardness is not obtained at the expense of safety. In conclusion, a series of photo-micrographs is reproduced, each pair of prints showing the structure of the steel before and after treatment respectively, with varying ranges of carbon and under varying degrees of magnification. The first four photographs relate to steel rails manufactured at the Cleveland Works; the last two, in which the comparison is perhaps the most striking, are given to show the effect in the case of a steel of over 0.70 % carbon content. The steel in this case formed part of a Sandberg sorbitic railway tire, tire treating plants having been laid down more extensively up to the present, than those concerned with the sorbitic treatment of rails, in which a rather more complicated and extensive equipment is necessary.

The application of alternating current supply with battery reserve to signal systems,

By H. G. MORGAN.

(Proceedings of the signal section of the American Railway Association.)

The use of commercial power for railway signaling with an emergency reserve battery has grown to considerable proportions in the last two years and some observations as to results obtained with various applications should be of interest.

Commercial energy is cheap, costing 3 % or less of the cost of energy from primary batteries. However, where the total amount of energy used per month is very small, the cost of primary battery may be less than the cost of commercial energy when all factors are considered.

Take for example a battery of eight cells of Edison type primary battery 500 A. H. capacity requiring renewal once a year. Figuring 90 cents a renewal and allowing an hour's time of a maintainer at 72 cents and a helper at 47 cents, the cost of energy per year is \$9.00, after allowance of 5 % depreciation is made on battery jars.

If this line battery is replaced by three cells of storage battery charged by a rectifier taking 13 watts for load and losses, the annual cost of energy with no allowance for labor amounts to \$14.00 where energy costs 10 cents per kilowatt-hour after allowance of 10 % is made for depreciation of battery and rectifier.

Now take a motor battery of sixteen cells of Edison type primary battery 500 A. H. capacity requiring renewal once a year. Figuring 90 cents a cell renewal and allowing two hours time of a maintainer at 72 cents per hour and of a helper at 47 cents per hour for re-

newal, the cost of energy per year is \$18.00, after allowance of 5 % depreciation on battery jars.

If this motor battery is replaced by four cells of lead type storage battery charged by a rectifier taking 13 watts for load and losses, the annual cost of energy with no allowance for labor amounts to \$16.50 where energy costs 10 cents per kilowatt-hour after allowance of 10 % for depreciation of battery and rectifier.

If the power rate is 5 cents per kilowatt-hour, the line battery will cost \$9.00 with primary battery and \$9.00 with storage battery, and the motor battery will cost \$18.00 with primary battery and \$15.75 with storage battery.

If the rectifier takes less than 13 watts for load and losses, there will be a reduction of 40 cents a year for each watt below thirteen.

Savings by the use of commercial power are especially suggested where power is immediately available and energy requirements are considerable. This applies at crossing devices in cities and towns. Where there are a series of devices requiring considerable energy, the transmission of power suggests itself. This may apply to the use of commercial power for a series of crossing devices or light signals using primary battery for auxiliary devices requiring small amounts of energy. Or finally, the availability of power may suggest its use for all devices making a uniform system. We will take up these applications in turn.

The cost of supplying energy from commercial power line to an isolated device cannot fall below the service minimum, which is usually \$1.00 or \$1.50 per month. At 10 cents per kilowatt-hour, this corresponds to from 10 to 15 kilowatt-hours per month, corresponding to a twenty-four hour load of 14 to 20 watts. This will run a single rectifier delivering from 0.5 to 1 ampere at 10 volts.

From this it will be seen that two battery cell renewals per month approximate the cost of running a rectifier at 10 cents per kilowatt-hour. Where the ten cell battery operating a crossing device requires renewal two or more times a year, the use of commercial power, if available, should be considered. Expressed differently, where a crossing device requiring 1 ampere at 6 volts operates three or more hours per day or total daily requirements exceed 18 watt hours, use of commercial power should be considered.

First cost will vary with conditions depending on apparatus at the location. In general, more room in relay boxes will be required if storage battery charged by a rectifier is used, and more room will be required in battery housings if primary battery is used. We do not regard the housing of rectifiers and relays in battery receptacles as desirable. We did not resort to it for economy prior to our use of floating charge, and could not fairly credit any savings so accomplished to the floating charge system.

We may state roughly that in towns where there is switching and commercial power is readily available, it will pay to install a rectifier and storage battery to operate a wig-wag signal. Where wig-wag signals are used it is possible to operate the lamp directly from the A. C. line with a cutover relay, but the extra losses in the transformer and cutover relay make this uneconomical.

Where isolated devices will operate on

either direct or alternating current, as in the case of light signals, either storage or primary battery may be used as a reserve, by the use of a cutover relay operated by alternating current, which will switch the devices to the battery when the relay is deenergized. With storage battery this requires energizing both a relay and a rectifier instead of just a rectifier, as in the case of direct current devices which have to be on floating charge. However, it must be noted that the amount of energy delivered is not dependent on the capacity of the rectifier, but may greatly exceed it as the rectifier is only called upon to maintain the necessary reserve in case of interruption of alternating current supply.

The cost of the reserve supply with storage battery will be the cost of running the rectifier constantly, amounting to 7 kilowatt-hours a month costing 70 cents at 10 cents per kilowatt-hour. If interruptions total only a few hours a month, primary battery may be used as a reserve and cost less than storage battery, making due allowance for renewal of battery a sufficient time before exhaustion to maintain a reserve equal to that of the storage battery.

At isolated locations it is apparent that the reliability of the rectifier is of more importance than its efficiency.

In connection with highway crossing protection it is generally most economical to confine the use of commercial power to the crossing device.

Our use of mechanical rectifiers began on our Chicago Terminal, where we had storage batteries at each signal bridge location, charged periodically by small motor generator sets.

These storage batteries operated the Hall disc signals and line circuits. Track circuits were operated by primary batteries. It was easy to substitute mechanical rectifiers for the motor generator sets as the loads were small. Later when colored light signals were substi-

tuted for the Hall disc signals, it was very simple to operate the signal lamps with the alternating current supply available, using a cutover relay to switch the lamps to the storage battery as a reserve. By this method we have satisfactorily and economically operated colored light signals without having to provide any duplicate source of alternating current. Last year during the extensive changes in grade and alignment which were being made preparatory to the electrification of our Chicago Terminal, we operated colored light signals by means of temporary power connections from suburban stations or any place that was available, using temporary storage battery housings. We were thus able to maintain uninterrupted service through a series of track and signal re-arrangements when no permanent arrangement was possible. There is no way of figuring the savings effected, but the storage batteries and rectifiers will be available for use on other parts of the system after electrification, two years hence. Storage batteries have been used for track circuits where convenient to locate them along with other batteries. Otherwise primary batteries have been used.

The use of a primary battery reserve would not have been practical, as there were frequent power interruptions, and batteries were frequently moved and subject to low temperatures.

We come next to the operation of devices requiring considerable amounts of energy, using a transmission line.

At one point we had four miles of very busy single track with seven top post semaphore mechanisms of an old type which were worn out.

It was desired to substitute colored light signals. We obtained power supply near the center of the system and put up transmission wires using 110 volts. Rectifiers and storage batteries were substituted for the primary batteries operating the signals. Track circuits were not changed. These seven signals which are

equipped with 30 watt lamps cost us \$20.50 per month at 7.4 cents per kilowatt-hour, or about \$3.00 per signal per month. The power supply has proven very reliable and we unquestionably could have kept our primary batteries for reserve.

On a double track suburban branch line in Chicago Terminal territory, we had track circuits and line in place for operation of annunciators in gate towers. In order to install colored light signals, we put up short stretches of line from frequent sources of supply using 110 volts and installed storage batteries and rectifiers for operation of signals only. This arrangement was unquestionably economical as the branch will be electrified within two years.

We now come to the transmission of commercial power for operating all parts of a signal system using battery reserve.

We have installed semaphore signals using floating charge with mechanical rectifiers for all purposes, on three short sections. On these installations we have used separate batteries for line and motor circuits, the same as we would do with primary batteries. Continuous lighting has been employed using 10 volt 0.25 ampere lamps.

First cost of this type of installation is about 10 % higher than our standard type of installation with primary batteries. This is based on transmission wires being located on same crossarm with other signal wires.

The cost of energy on a sliding rate averaging about 6 cents per kilowatt-hour on one section of 11.5 miles, with fifteen signals has amounted to \$27.00 per month. Cost of primary battery renewals on this section would have amounted to approximately \$30.60 per month for material only, using approach lighting. One assistant maintainer was added to the force on account of these additional signals. Maintenance of this section has been easier than with pri-

mary battery and we have continuous lighting but no saving has been effected. We feel that more territory can be assigned, where floating charge is used with semaphore signaling than where primary battery is used throughout and any saving must be due to the reduction of labor.

The thought may occur that in such a system the line circuits which take so little energy could be more cheaply operated by primary battery and the remainder of the system by storage battery.

On the 11.5 mile installation just mentioned the energy required to operate fifteen line circuits one month is estimated at 105 kilowatt-hours allowing for line losses. Elimination of this item would reduce our monthly bill by \$5.25, the minimum rate on the sliding scale being 5 cents per kilowatt-hour. These line circuits would require approximately nine 500 A. H. primary battery renewals per month at a cost of \$8.10.

Insofar as semaphore signals are concerned, it appears that floating charge with storage battery should be used throughout, or else primary battery should be used throughout.

We have installed 90 miles of absolute permissive block signaling using colored light signals.

The cost of installation using commercial power with storage batteries charged from mechanical rectifiers as a reserve runs about 10 % higher than using primary batteries with approach lighting. These figures will vary somewhat with the type of construction employed. We have used No. 6 weatherproof copper transmission wires on the signal arm with step-down transformers at each signal location. Signals are constantly lighted using an 18 watt 10 volt lamp controlled direct from the line with a cutover relay to switch to the reserve storage battery. Reserve storage battery is used to operate line circuits, line relays being 640 or 670 ohms resistance. All apparatus is housed on the line side,

standard double cases being used. A twenty mile section is assigned to a maintainer without a helper. Power bills for a section with twelve trains a day at 7 cents per kilowatt-hour amount to \$4.75 per signal and \$6.88 per track mile per month. Power bills for a section with sixteen trains per day at 8 cents per kilowatt-hour amount to \$4.27 per signal and \$7.50 per track mile per month.

The cost of operating a similar section with primary batteries and approach lighting amounts to \$3.00 per signal per month for signal battery renewals alone. It should be noted that this is based on the use of a 10 volt 18 watt lamp. We are experimenting with a 7 1/2 volt 10 watt lamp and results so far have been satisfactory. I understand that lamps of lower wattage than 10 are being tried for this intermittent service. It is obvious that the development of highly efficient colored light signals may make the use of primary battery compare favorably with the use of commercial power. It should also be noted that the approach lighting on this section is controlled by the relays for the opposite signals and that for each train movement the signal lamps are lighted an average of one-half the time it takes the train to go the full length of the absolute block between sidings. There are twelve train movements per day. A maintainer and helper are required for this section. The extra labor makes this arrangement more expensive.

Sources of commercial power are frequently very reliable, and the energy which the reserve battery is called upon to deliver per year may be very small. Where the apparatus will work on either direct or alternating current, as in the case of the light signals, a primary battery reserve may prove more economical than a storage battery reserve. We have made no practical application of this principle as yet.

We have employed commercial power

with storage battery reserve on a section of 7 miles of four-track road and 26 miles of three-track road. On the three-track road, the middle track is signaled for traffic in both directions. On this section a separate signal pole line was already in place, having been built in connection with previous double track signaling. Two No. 6 A. W. G. double braid weatherproof hard drawn copper line wires were strung for the 440 volt transmission line.

Each bridge in this territory carries four colored light signals which are constantly lighted. The use of approach lighting was not considered desirable where signals are displayed for more than one track in the same direction.

The use of storage battery for track circuits made possible the operation of track circuits the full length of the blocks, which average 5 000 feet with a maximum of one mile.

Primary battery was not considered for the above reasons.

A comparison of the cost of the floating charge system and the alternating current system shows that the cost of apparatus for one bridge amounts to approximately \$1 400.00 for the floating system and \$1 800.00 for the alternating current system. It is to be observed that this figure includes the reserve for the floating system but does not include the cost of duplicate power supply for the alternating current system. It is our experience that one system may be maintained as cheaply as the other.

A few general observations may be of interest.

In laying out transmission lines, where wires have to be placed on the end pins of the signal crossarm on telegraph pole line, we have used No. 6 A. W. G. hard drawn weatherproof copper wire. We have felt that this wire is as large as may be satisfactorily used, and that its mechanical strength is about as low as is desirable for a transmission line.

Wherever we have used line voltages

of more than 110 volts, in order that maintainers may not have to handle higher than 110 volts except on the line, we have used line transformers at all locations grounding one side of the 110 volt secondary. This permits a greater standardization of rectifiers.

It is very important that transformers be of no greater rating than actually required and that they be efficient; otherwise transformer losses may form a considerable portion of the line load. Small aircooled transformers are available for mounting on crossarm in ratings of 50, 100, 150, 200, 250, 500 and 750 watts. These are similar to transformers used for sign lighting and provided with 5 and 10 % voltage regulation taps inside the primary winding.

Booster transformers may be used to slightly extend the length of transmission lines, but it is much better to lay out a line on the basis of ample margin without boosting.

For the operation of colored light signals on single track we have used transmission at 220 volts on Postal lines and 440 volts on Western Union lines using No. 6 copper in each case. The 440 volt arrangement is much more satisfactory. With 440 volt operation it is practical to make longer transmission from points where a lower rate and better service is obtained, making transmission as short as possible from small stations carrying a high rate and giving unreliable service. In general it is not feasible to use sectionalizing switches to supply power from either end of the line as the transformer adjustments all have to be changed.

Maximum lengths of our power transmission lines are as follows :

Three and four-track colored light signaling using 440 volts, 6 miles.

Single track colored light signaling 440 volts, 14 miles.

Single track semaphore signaling using 220 volts, 10 miles.

It is worthy of note that the use of primary battery reserve with colored light signals would permit the use of longer transmission lines.

Lightning arresters for pole mounting have only recently become available. It is now possible to secure a compression chamber arrester designed for 440 volts and of small enough capacity for the light loads carried on signal lines. Some of the carborundum types of arresters which have been in use on signal lines for years may be employed in a suitably designed box, mounted on the crossarm.

Suitable reserve capacity should be provided to guard against failure. This is a more difficult matter than at first appears, inasmuch as an individual rectifier may fail without there being anything special to call the maintainer's attention to it, and continue until the battery runs down; while a failure of power supply is observed at any location

and when power comes on again normal operation is resumed. For this reason we have used nothing smaller than a cell of 75 ampere hours rating on intermittent 1 ampere discharge.

Satisfactory rectifiers may be secured, some using both sides of the wave and others using one side of the wave. Where one manufacturer produces both types, our preference has been for the double wave type due to the fact that the contacts had to break only half as much current in the single wave type, although the single wave type is more efficient on light loads. Contacts now available appear to be satisfactory.

In conclusion we may state that satisfactory service is obtainable by the use of commercial power with reserve battery. Considerable economies may also be effected, but each installation should be carefully considered on its individual merits.

MISCELLANEOUS INFORMATION

[331. 61]

1. — First World Power Conference.

English engineers specialising in large central steam-electric and hydro-electric power station, arranged during the British Empire Exhibition at Wembley, an International Conference, the object of which was defined as follows :

« The purpose of the World Power Conference is to consider how the industrial and scientific sources of power may be adjusted nationally and internationally :

« By considering the potential resources of each country in hydro-electric power, oil and minerals ;

« By comparing experiences in the development of scientific agriculture, irrigation and transportation by land, air, and water ;

« By conferences of civil, electrical, mechanical, marine and mining engineers, technical experts and authorities on scientific and industrial research ;

« By consultations of the consumers of power and the manufacturers of the instruments of production ;

« By conferences on technical education to review the educational methods in different countries, and to consider means by which existing facilities may be improved ;

« By discussions on the financial and economic aspects of industry, nationally and internationally ;

« By conferences on the possibility of establishing a Permanent World Bureau for the collection of data, the preparation of inventories of the world's resources, and the exchange of industrial and scientific information through appointed representatives in various countries. »

The first World Power Conference held its meetings at Wembley from the 30 June to the 11 July 1924.

Thirty-seven countries were represented, and several of these, notably the United States, Sweden, Italy, Switzerland and Czecho-Slovakia, sent a large number of delegates.

377 papers were arranged for, and 250 of these were printed and distributed before the Conference.

The large number of papers to be considered rendered it necessary to split the Conference into a considerable number of sections, which were arranged as follows :

Section A. — Sources of power in various countries ;

Section B. — Water power production ;

Section C. — Preparation of fuels ;

Section D. — Steam power production ;

Section E. — Internal combustion engines ;

Section F. — Power produced from other sources ;

Section G. — Production and distribution of power (Electric) ;

Section H. — Power in industry ;

Section J. — Power in electro-chemistry and electro-metallurgy ;

Section K. — Power for transportation ;

Section L. — Power for lighting ;

Section M. — Economic, financial and legal aspects of power ;

Section N. — General.

It will be recognised that the ground laid down by the organisers to be covered was very extensive. The result of the large number of papers was that each author was only allowed a few minutes in which to give a summary of his paper, and the shortness of time did not allow of a general discussion from which conclusions could be drawn.

The interest attached to a large number of the papers was, nevertheless very great, because, even to-day, several matters relating

to various aspects of the production, distribution and use of power have not been dealt with from an international standpoint. In this respect, peculiar interest, from a technical point of view, was attached to papers in sections C, J, K and M, and from a statistical point of view, to those in sections A, B, G and H.

Section K, as stated above, dealt with all matters relating to the application of power to transportation. One found included in this section original papers dealing with railways worked by steam or electricity, transportation by water and by air. We give below a list of the papers published and dealing with transportation by rail:

No. 312. — Electrification of railways in the Dutch East Indies, by Dr G. de Gelder, chief engineer Electrical Department D. E. I., State Railways (Java);

No. 326. — Some considerations on the development of railway and tramway traction, by professor I. Franco, M. E., superintendent of the Netherland Railways Motive Power, Electric Traction Department;

No. 328. — Electric traction in Italy, by professor F. Tajani;

No. 329. — Electrification of railways in Norway, by H. J. Schreiner, chief electrical engineer, Norwegian State Railways;

No. 330. — Power problems of the Swedish Railways, by I. Öfverholm, chief electrical engineer, Swedish State Railways;

No. 336. — Main line electrification on the State Railways in Germany, by Wilhelm Weekmann, Ministerialrat, Ministry of Transport and Railways, Berlin.

The result of the various experiments collected together from various sources made one trust that the next Word Power Conference might be limited to subjects which are not regularly dealt with by other international organisations, such, for example, as:

The International Railway Congress;

The International Electric-Technical Congress;

The Main Line Electrical Conference.

The offices of the World Power Conference are at 36, Kingsway, London, W. C. 2.

EM. UYTBORCK.

[625. 144.2 & 625. 144.4]

2. — Apparatus for indicating the conditions of the superelevation of the outer-rail on railway curves,

By WILLIAM J. SHELDON, M. Inst. C. E.,

CHIEF ENGINEER OF PERMANENT WAY, SÃO PAULO RAILWAY (BRAZIL).

Fig. 1, p. 1177.

(Sessional notices of the Institution of Civil Engineers [London]).

This apparatus has been recently designed by the Author for use on the São Paulo Railway Company of São Paulo, Brazil, of which he is chief engineer. The mechanism (fig. 1) is mounted on a four-wheeled trolley of light construction, its total weight being 100 kgr. (220 lb.) for the 5-ft. 3-in. gauge of this railway, and it can be easily propelled by one man. The apparatus is driven from the axle of the trolley by worm gearing which rotates the drum to which is attached the chart for

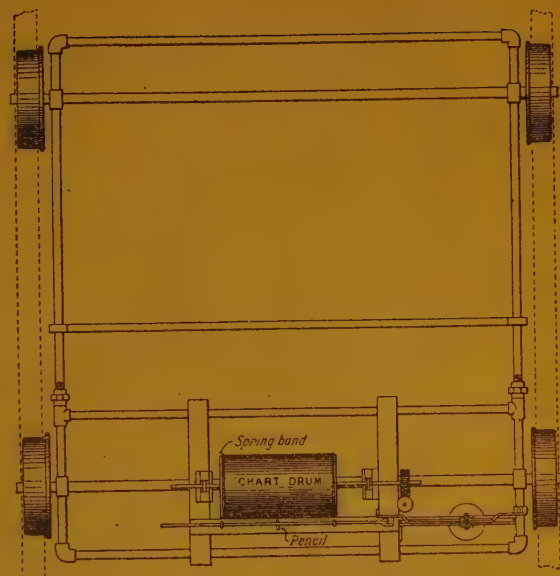
recording the exact distance travelled along the curve. A pendulum device indicates automatically on this chart the superelevation which exists on the curve investigated.

The apparatus has been designed for indicating the conditions of the superelevation on the most important curves, and more specially of the run out on the short tangents which exist between certain curves of minimum radius. These data are recorded or reproduced on a chart in quite a satisfactory manner and at

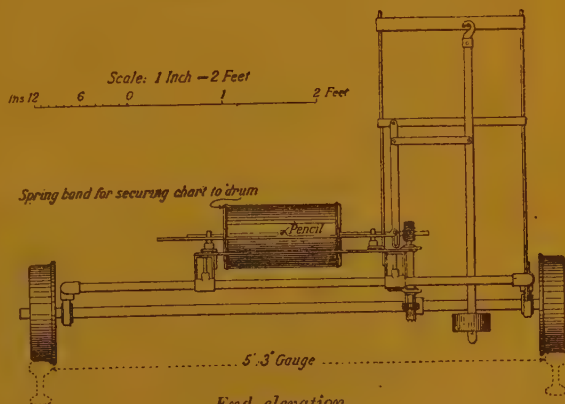
small expense, and thus enable the District Engineer and Permanent-Way Inspector to have in a few minutes a true record of the conditions of a curve.

The gearing on the axle which rotates the chart-drum is arranged so that the scale of reduction to which the movement of the trolley is shown on the chart is 1/1000. The drum is 20 cm. (8 inches) in diameter, so that 600 m. (30 chains) of curve can be recorded on the chart with one revolution of the drum. The rotation of the drum can be put out of action, when travelling over a stretch of straight track, by loosening a thumb-screw which connects it to the spindle.

The chart-pencil is attached to a sliding bar, which is operated by the action of the pendulum and indicates on the chart to a natural scale the exact superelevation of the curve investigated. The chart is secured to the drum at the ends by circular steel bands which can be detached from the drum in a few seconds. The P. C. and P. T. of the curves on this railway are indicated by short posts made of old fish-plates or pieces of rail fixed in the road-bed to one side of the track; these also serve as points of reference on the chart, as their respective positions can be indicated by simply moving the pendulum by hand and so drawing a pencil line on the chart corresponding to these places. These short posts have the required amount of superelevation of the outer rail indicated on them by a vertical cut, which facilitates the work of the permanent-way ganger and inspectors in measuring this on the spot with an ordinary rule, and thus dispenses with Tables. The trolley proper is made in two parts, connected by two union nuts, which enables it to be easily transported in the baggage van of a passenger-train to any part of the railway, as the heavier part only weighs about 70 kgr. (154 lb.).



Plan.



End elevation.

Fig. 1.

[625 .151 (.75)]

3. — Wheel guiding flange frogs for St. Louis Terminal.

Figs. 2 and 3, p. 1179.

(Engineer in, News-Record.)

In the improvement of the complicated track layout of the Terminal Railroad Association of St. Louis, Mo., a conspicuous feature is the extensive use of flange frogs of the Graham type, with which each wheel passing through the frog is guided by its rim, or outer edge of the tread, engaging a rib or flange which projects above the level of the rail head. This arrangement is quite distinct from the ordinary construction, where each wheel passing through the frog is guided by means of the wheel on the opposite end of the axle, the back of the flange of this latter wheel engaging a guard rail adjacent to the track rail opposite the frog. Thus each flange frog eliminates the two guard rails and their attachments.

In the No. 7 solid manganese cast frog of this type, as made for the St. Louis installation and shown in figure 2, it will be seen that the flange is 1 1/4 inches high above the rail and 1 1/4 inches wide. At the throat, this flange flares away from the gage line of the frog, an arrangement which is said to give an easier entrance angle and less shock to the wheels in engaging the flange than would be the case if the frog flange was parallel with the gage line. Projections serving as tie-plates are formed on the base of the frog casting, and at both ends of the frog the connecting rails, of 100-lb. section, are supported by tie-plates.

Another frog of the same type, but built up of rails and manganese steel castings is shown in figure 3. These frogs, which are used less extensively than the cast frogs, are designed for use where the flange frogs have to be fitted to existing layouts and rail joints, being made interchangeable with the ordinary type of frog. In this case, it will be noted that the flange castings form a continuous base for the rails, which are thus held up to their work, the whole structure being well bolted together.

Flange frogs are being applied largely in yard work and in other locations where switching movements are numerous. They are not so well adapted to main-line work, since main-track turnouts usually have spring-rail frogs to give smooth running. However, the makers consider the flange frog suitable for main-line crossovers used frequently for switching movements. This is indicated by the use of these frogs for practically all of the tracks of the St. Louis Union Station and terminal layout where passenger trains operate at considerable speed.

About three years ago a dozen of these flange frogs were installed by the Terminal Railroad Association in the track layout of the St. Louis Union Station, and they proved so satisfactory that this type was adopted for all frogs, except in high-speed main tracks. The flange frog is found to be much more satisfactory than the ordinary type of frog with guard rail; in fact, it is stated that when a frog of the flange type is installed it requires little if any more attention than an equivalent stretch of unbroken track. Furthermore, the engineer considers that the flange frog will materially reduce the liability of derailment and will also reduce the tie renewals now made necessary by damage due to continual respiking of guard rails, while it will eliminate the constant work and expense for adjusting guard rails to maintain proper width of flangeway. The flange frogs for this installation were made by the St. Louis Frog & Switch Co., under license from the American Flange Frog & Railway Improvement Co., which latter company owns the patents granted to John E. Graham and has given license to several manufacturers. The work of improving the yard layout is under the direction of H. J. Pfeifer, chief engineer of the Terminal Railroad Association of St. Louis.

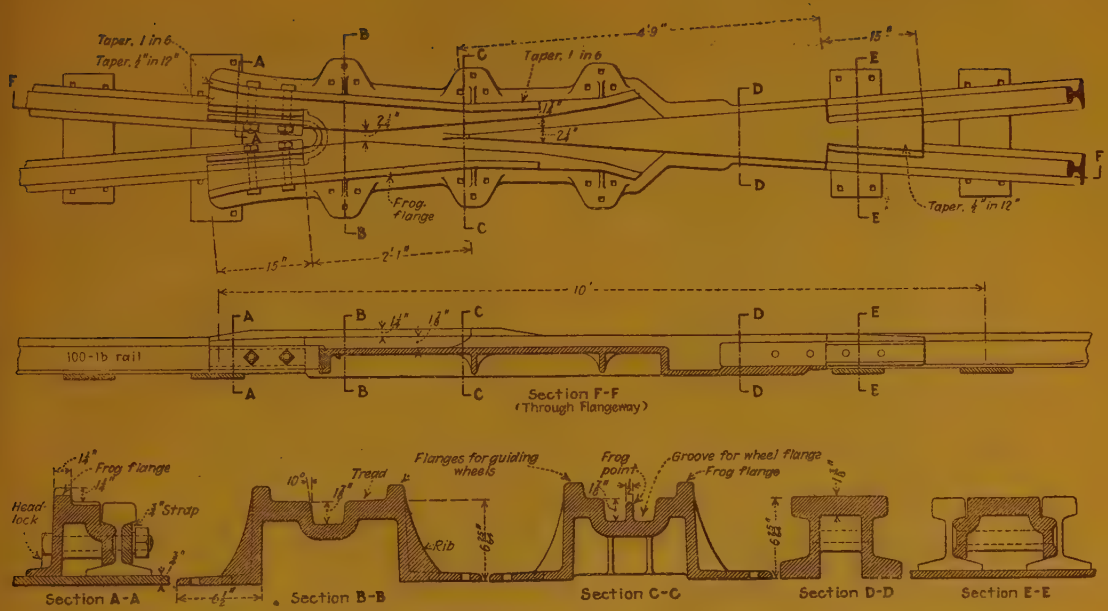


Fig. 2. — Cast-manganese flange frogs for Terminal Railroad Association of St. Louis.

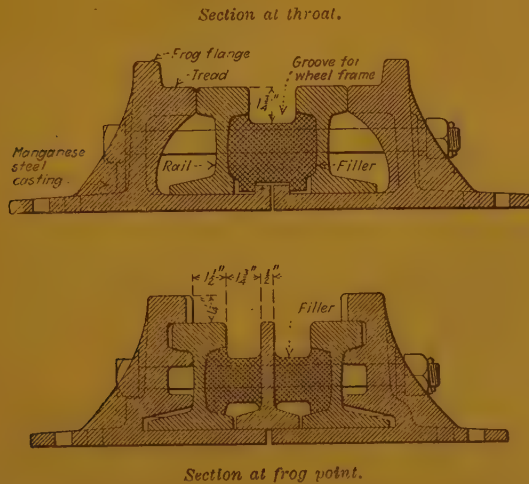


Fig. 3. — Details of built-up flange frog.

[624.152.3 (.45)]

4. — New locomotives « Mikado » class (2-8-2) for working heavy through trains over hilly sections of the Italian State Railways.

By ENRICO LEVI, engineer.

Fig. 4, p. 1181.

(*Rivista tecnica delle Ferrovie Italiane.*)

The locomotives of class 746, which have just been put into service, were constructed by the *Società Italiana*, of which E. Breda is engineer, to the designs of the Locomotive Department of the Italian State Railways.

In the meantime, whilst waiting until the usual running tests have been made, we propose giving a brief description of these engines, including the alterations made to the original design during the process of construction.

Figure 4 shows the general arrangement of the locomotive, which is of the 2-8-2 type, called by the Americans the *Mikado*.

The front carrying axle and the first coupled axle are connected together through the medium of a bissel truck arrangement of the well known Italian system, already largely fitted to locomotives on the State Railways. The wheels of the four coupled axles, are 1 m. 88 (6 ft. 2 in.) diameter with new tyres, the fourth axle (the third coupled) being the driving axle.

The carrying axle under the firebox has a radial displacement and is connected by means of a special frame to a pivot round which it can turn, forming therefore a radial truck of an interesting type, which is copied from American locomotive practice. The journals of this axle are outside and consequently very suitably placed to avoid heating, and as regards protection from ashes and clinker which might fall from the ashpan. The framework of the truck carries the locomotive through the medium of slides placed between the lower part of the main frames and the top part of the framing of the truck. The latter, in its turn, is supported by means of hangers attached to the springs of the trailing coupled axle and by ordinary plate springs placed above the truck axle boxes. The pivot placed

in the centre line of the framing and fixed to a cross beam of the latter serves as a guide for the movement of the truck. The frames of the truck, having to withstand considerable torsional stresses, are made of strong steel members, of rectangular section.

Following the plan adopted on other locomotives of the Italian State Railways, there is no side control arrangement for centring the trailing truck in relation to the main framing.

The suspension springs of the rear three coupled axles are joined together by means of compensating beams, and those of the trailing coupled axle are also connected to the springs of the trailing carrying axle through the truck framing. On account of the position of the slides which transmit the weight on to the trailing truck, this is approximately equal to that on each of the coupled axles, and so by this means it has been possible to satisfy the requirements of the Permanent Way Department and limit the weight on each axle to a little over 16 t. It was necessary, however, for this purpose to increase the load somewhat on the front carrying axle. Necessary arrangements have been made so that by an easy adjustment of the slides transmitting the weight to the trailing truck, the load thereon may be reduced and increased on the coupled axles, so that, if necessary, the adhesive weight of the locomotive may be increased to a certain extent.

The framing of the engine is made of steel plates.

The boiler is fitted with a superheater. The firebox is lengthened in front by means of a combustion chamber, and the tubes are 5 m. 800 (19 ft. 0 3/8 in.) long of which there are 180, 52 × 47 mm. (2 1/16 × 1 7/8 inches) and 27, 133 × 125 mm. (5 1/4 × 4 15/16 inches)

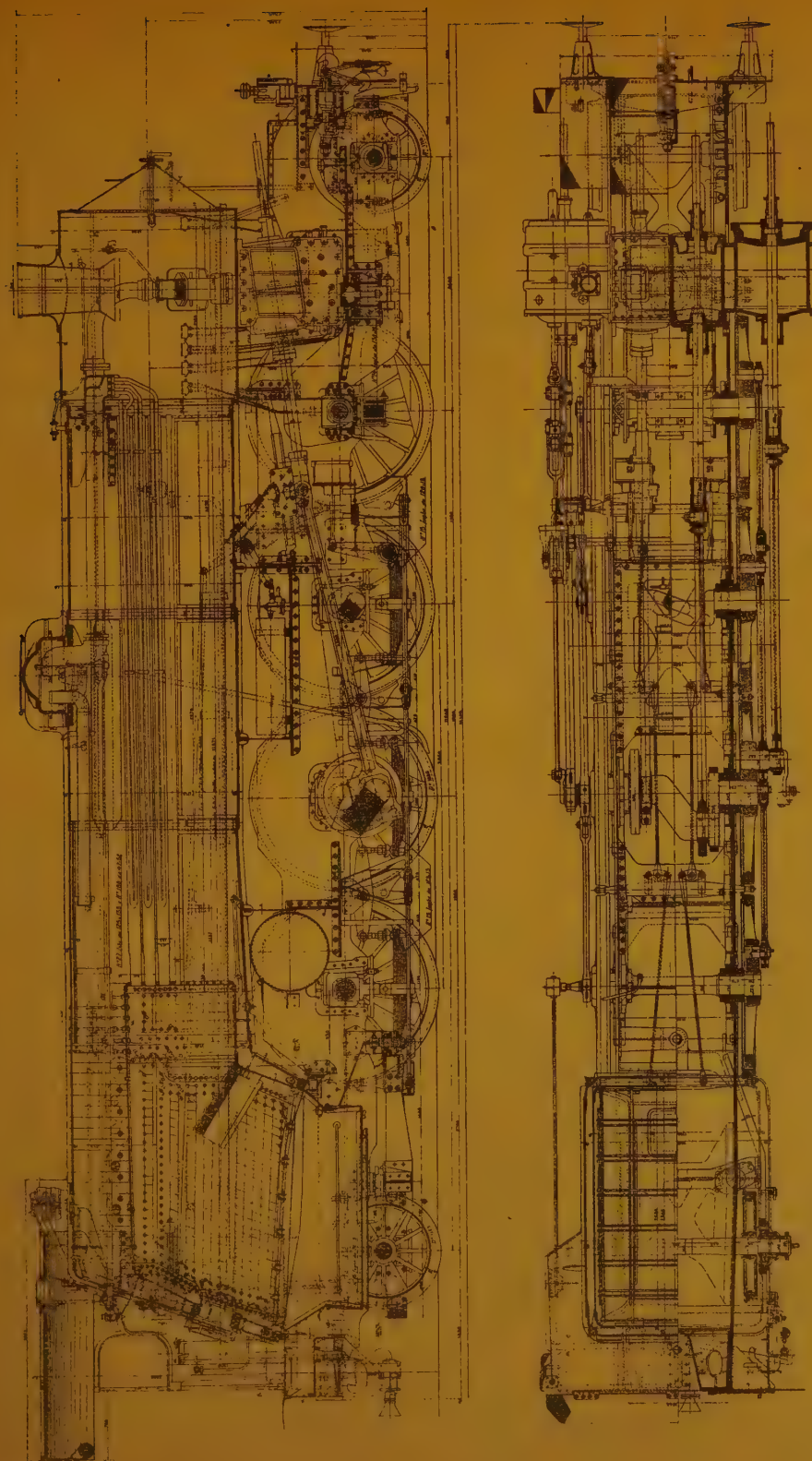


Fig. 4. — New locomotive *Mikado* (2-8-2) of the Italian State Railways. — General view.

in diameter; the latter contain the elements of the Schmidt type, which are 29×36 mm. ($1 \frac{9}{64} \times 1 \frac{27}{64}$ inches) in diameter.

The grate has an area of 4.30 m^2 ($46 \frac{1}{2}$ square feet) and is made of triple cast iron firebars of the standard type used on the Italian State Railways.

In order to obtain the maximum economy in steam and consequently in fuel, the engine is a four cylinder compound.

The high pressure cylinders are 490 mm. ($19 \frac{5}{16}$ inches) and the lower pressure 720 mm. ($28 \frac{3}{8}$ inches) in diameter. They are placed all in a line together, the low pressure being fixed outside the frames, and the high pressure between them. It was not possible, even if it had been desired, to make use of the well known arrangement adopted on the other four cylinder compound locomotives of the Italian State Railways (high pressure cylinders on one side and the low pressure ones on the other, two inside and two outside) there not being sufficient room between the frames.

The proportion between the volumes of the cylinders is about 2.16, which appears to be suitable for compound locomotives using superheated steam, and also allows a high tractive effort to be developed, when necessary, for short distances by lengthening the cut-off in the high pressure cylinders.

With this ratio, however, it is necessary, in order to obtain a good distribution of the work between the two groups of cylinders, that the admission to the low pressure cylinders should be from 10 % to 15 % greater than that in the high pressure cylinders.

If it had been desirable to arrange for the distribution of the steam into one pair of cylinders to be effected by means of one valve only, the difference between the degrees of admission would have had to be obtained by a difference between the steam laps, but this would not have produced a satisfactory distribution in both the cylinders. Separate valves were therefore adopted for the high and low pressure cylinders, and are worked on each side of the locomotive by means of Walschaerts type of motion, the movement of the two valves being obtained from two different points

on the one lever used for giving the lead. The low pressure valve rod is coupled directly to this lever, and that of the high pressure valve by means of a rocking shaft.

Piston valves are used for both cylinders, with inside admission for the low pressure cylinders and outside admission for the high pressure. By this means it has been possible to give the minimum amount of clearance volume and a direct route for the steam.

To facilitate starting, the driver has an apparatus worked by hand consisting of a valve which, when drawn away from its normal position, allows steam from the boiler to pass, at a suitably reduced pressure, into the receiver formed by the high pressure exhaust passages and low pressure steam chests.

The driving axle is the third coupled axle which allows the connecting rods to be of good length, and consequently without excessive obliquity.

The outside cylinders are placed horizontally, whilst the inside ones are inclined 7° upwards.

The second coupled axle is cranked so as to avoid the inside connecting rods.

The cylinders are fitted with the valve adopted by the Italian State Railways and used for various purposes, relief valve, air valve and drain cock (1).

The engine is fitted with mechanical lubricators for cylinders and valves, the oil being emulsified with a steam jet.

The engine head lamps and cab lamps are electrically lighted.

It is also supplied with all the usual accessory fittings that are in use on the Italian State Railways, of which we may mention :

1° Double Westinghouse air brake equipment is provided, *i. e.*, both automatic rapid acting and also direct acting, the coupled wheels of the engine and the tender wheels all being braked; the automatic brake also acts upon the train;

(1) See the description of this valve in the *International Railway Congress Bulletin* of June 1924, p. 486.

2° Haag apparatus for heating the trains by steam;

3° Non-lifting injectors;

4° Zera equilibrium valve type of regulator;

5° Coale's lock-up « pop » safety valves;

6° Hasler speed recorder;

7° Leach's compressed air sanding arrangement.

The tender is carried on two four-wheeled bogies; it carries 22 m³ (4 840 English gallons) of water and 6 t. of coal.

The principal dimensions and particulars of the engines are as follows :

Boiler :

Total length	11. 695 m. (38 ft. 4 1/2 in.).
Volume of water with 10 cm. (4 inches) over crown of firebox	8.100 m ³ (286.06 cubic feet).
Steam space	4 m ³ (141.26 cubic feet).
Pressure	14 kgr. (199.11 lb. per square inch).

Fire grate :

Length	2.50 m. (8 ft. 2 1/2 in.).
Width	1.700 m. (5 ft. 7 in.).
Area (G)	4.30 m ² (46.27 square feet).

Firebox :

Mean height above grate	1.640 m. (5 ft. 4 1/2 in.).
Length (at top)	3.050 m. (10 feet).
Width (at top)	1.430 m. (4 ft. 8 5/16 in.).
Combustion chamber : length	0.789 m. (2 ft. 7 3/32 in.).
— — height	1.105 m. (3 ft. 7 1/2 in.).
— — maximum width	1.480 m. (4 ft. 10 5/16 in.).

Tubes (plain type) :

Length between plates	5.800 m. (19 feet).
Number—180 : 52 × 47 mm. (2 1/16 × 1 7/8 inc' es).	
— 27 : 133 × 125 mm. (5 1/4 × 4 15/16 inches).	

Heating surface, fire side :

Firebox	17.00 m ² (183.00 square feet).
Tubes	215.00 m ² (2 314.30 — —).
Total (S).	232.00 m ² (2 497.30 square feet).

$$\text{Ratio } \frac{S}{G} = 54$$

Superheater area (S'). 67.00 m². (721.20 sq. ft.).

$$\text{Ratio } \frac{S'}{S} = 3.5$$

Boiler barrel :

Inside diameter) maximum	1.820 m. (5 ft. 11 11/16 in.).
) minimum	1.680 m. (5 ft. 6 3/16 in.).
Length, including smokebox	8.965 m. (29 ft. 5 in.).

Smokebox :

Length	2.100 m. (6 ft. 10 11/16 in.).
Diameter	1.820 m. (5 ft. 11 11/16 in.).
Fixed circular exhaust orifice	

Chimney :

Maximum diameter.	520 mm. (1 ft. 8 $\frac{1}{2}$ in.).
Minimum.	4 5 mm. (1 ft. 5 $\frac{1}{8}$ in.).

Motion :

Diameter of H. P. cylinders	490 mm. (19 $\frac{1}{4}$ inches).
— L. P. —	720 mm. (28 $\frac{3}{8}$ inches).
Length of stroke.	6.0 mm. (26 $\frac{3}{4}$ inches).
Wheel diameters at contact (with new tyres).	1.880 m. (6 ft. 2 in.).
Ratio between the volumes of the H. P. and L. P. cylinders.	2.16
Total weight of locomotive in working order	92.31 t.
Weight empty.	84.24 t.
Adhesive weight	63.77 t.
Total weight of tender in working order	49.30 t.
Total weight of tender empty (with equipment)	21.74 t.
Water capacity	22 m ³ (4 840 English gallons).
Coal	5.90 t.

[621 .33 (.73)]

5. — Electrification of the Fort Washington Branch of the Pennsylvania Railroad.

Figs. 5 and 6, p. 1185.

The *Railway Review* of 10 May 1924 contains an article describing the main characteristics of this electrification. It consists of a single line branch 6.2 miles in length, to which has been extended the 11 000 volts, single phase alternating system, used on the contiguous electrified lines. The interesting feature of this electrification consists in it shewing the ease with which electric motive power can be extended to moderate distances in connection with a previous installation.

Six trains run daily in each direction on the branch, two of them going into Broad Street Station, the remainder terminating at a junction. The country traversed is very rolling, with a maximum gradient of 1.5 % over a distance of 2.6 miles. Curves of 2, 4, 7 and 9° obtain, the latter being 1 200 feet long.

The trolley wire carrying 11 000 volts has been simply connected to the existing installation without the necessity of providing an additional sub-station. The wire is supported from wooden poles, normally spaced 125 feet,

by angle iron brackets which carry the standard catenary wire system having a 1/2 inch galvanised cable, No. « 00 » B & S. (0.3648 inch diameter) copper auxiliary wire and No. « 000 » B & S (0.4096 inch diameter) phono-electric contact wire.

The poles are stayed with 3/8 inch galvanised steel wire, and every half mile the end of the bracket is connected with the poles on either side by a steel wire.

The figures which we reproduce show the very interesting aerial construction. Figure 5 shows the equipment on a curve of 9° in which the poles are only spaced 100 feet apart and shows a very interesting arrangement of catenary construction employed in order to prevent excessive vertical rise of wires when the pantograph passes. Figure 6 also shows a special type of construction used on an embankment where it was not possible to stay the poles and where the usual type of catenary construction could not be employed.

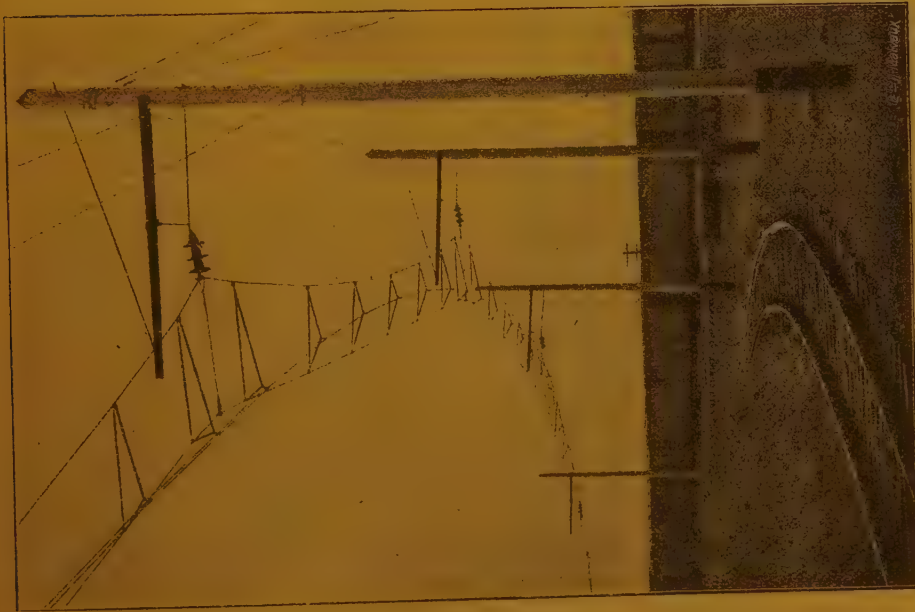


Fig. 5. — Overhead construction on a 9-degree curve, Port Washington Branch, Pennsylvania Railroad.

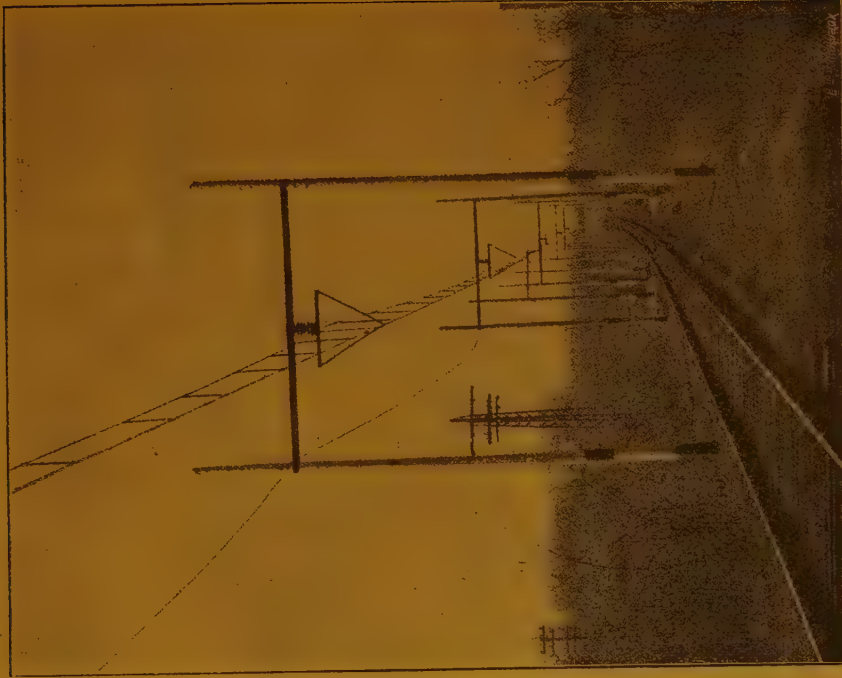


Fig. 6. — Overhead construction on tangent track on a fill where guying was not feasible, Pennsylvania Railroad's Fort Washington Branch.

[656 .253 (.75)]

6. — Winking signals facilitate yard switching,

By M. G. McINERNEY,

SUPERINTENDENT, BUFFALO, ROCHESTER & PITTSBURGH,
ROCHESTER, N. Y.

Fig. 7, p. 1186.

(*Railway Age*.)

A row of electric lights located on every second pole along the switching lead and controlled by snap switches by the switchmen are being used successfully as a means of giving switching signals to the enginemen for both day and night service at several yards on the Buffalo, Rochester & Pittsburgh. The following signaling code is used for this signaling :

- 1 long flash Stop
- 2 long flashes Go-ahead
- 2 short flashes Kick-ahead
- 3 long flashes Back-up
- 3 short flashes Kick-back
- 4 short flashes Steady

The system of winking signals is used on flat switching and has filled a long felt want, especially in stormy or foggy weather and on curves where it is difficult to pass hand signals. Aside from the more satisfactory results, these signals eliminate the services of one man formerly required to pass the hand signals on to the engineman. The track layout and the location of special winking light signals and controlling switches at Rickers, Pa., are shown in the accompanying plan. Electric lights are mounted on every second pole of the telegraph pole line for a sufficient distance to cover the space in which a switch engine ordinarily works, which may be from 30 to 70 car lengths. The lights at Rickers are distributed for a distance of about 3 000 feet.

The lights are mounted on the pole line, either under the cross-arm or on a bracket made of bent pipe fastened to the pole. The lamp is not provided with a shade but is constructed so as to be weatherproof. The size

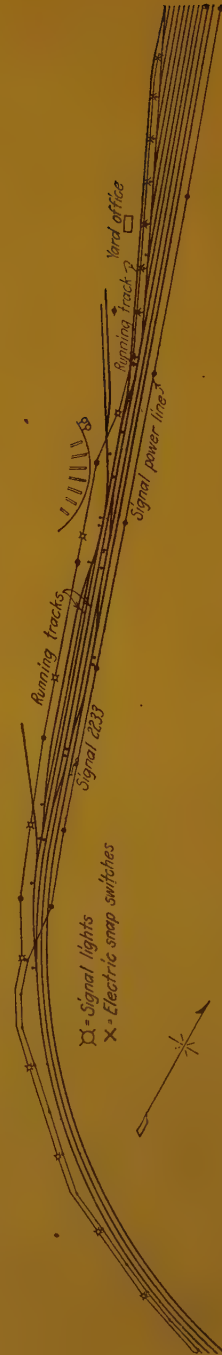


Fig. 7. — Plan of the yard at Rickers, Pa., showing location of signal lights and snap switches.

of the lamp used depends on local conditions, ordinarily a 25-watt lamp is satisfactory, but in case the view of any lamp is directly against the sun a larger lamp is required in order to transmit the daylight indication.

Control circuits and switching.

The lights are all flashed simultaneously and may be controlled by any one of the snap switches which are located near each of the yard switches. Where the pole line is close enough the switch is mounted on the pole up close to the cross-arm so that no

conduit is required. A length of bell cord extends from the switch down to a pulley on the pole which is mounted at a height for convenient use. The switchman pulls on the end of the cord to operate the switch. Where the pole is too far from the track the snap switch is mounted on a short pole set near the switch.

The cost of an installation depends on whether a pole line is available or whether one has to be built; whether it is necessary to lay conduit under tracks to the switches, etc. The installation shown on the drawing, in which there are 8 switches and 11 lights, costs approximately \$875.

[656.251 (.75)]

7. — New signals at the Chicago Union station.

Figs. 8 and 9, p. 1188.

The Railway Gazette.

The elimination of movable parts in the signal and the simplification of the signal indication are features being developed in signalling at this time. Pronounced advancement has been made in the use of lights for both day and night indications, thus eliminating the semaphore arm with its motor and operating mechanism. Two types of light signals are being used. An interesting study was included in a recent issue of the *Railway Age* (U.A.S.), from which the following extracts are taken.

One type extends the use of the coloured lights as formerly used only at night through the daylight period. This type is called the coloured light signal. The other type reproduces by lights the semaphore positions, extending them through the night period. This type is called the position light signal.

Giving signal indications by lights allows a flexibility of arrangement that is impossible with the semaphore arm. This makes it possible to reduce the size of signals materially and still give the required indications.

Advantage was taken of this in arranging the signal system for the Chicago Union Station where viaducts of a very attractive design

cross the tracks approximately 800 feet apart, the bottom of which are only 17 feet from the top of rail, at points where signals are required.

To have used the standard semaphore signal would have necessitated signal bridges on both sides of these viaducts which would have entirely obstructed the view of these attractive structures from the tracks. Hence a signal was designed of such a size that it could be attached readily to the viaducts and not interfere with the attractiveness of their design.

The signal indications required for the proper operation of the terminal were as follows :

1° « stop signal », indicating STOP, the route is not lined up;

2° « permissive signal », indicating that the route is lined up but that the track immediately ahead is occupied, giving authority to proceed with caution prepared to stop short of a train or obstruction;

3° « slow speed signal », indicating a divergence over a slow speed crossover to a track which is unoccupied but on which there may be a stop signal;

4° « caution signal », indicating that the immediate block is clear and the movement is

being made without divergence but to approach the next signal prepared to find it at stop;

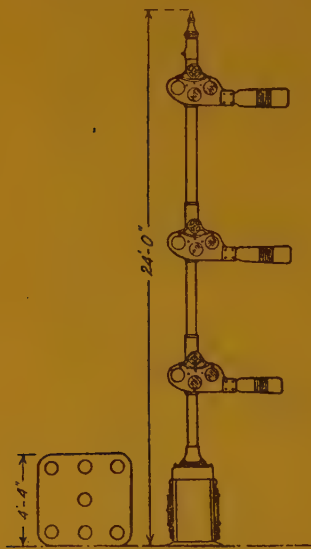


Fig. 8.

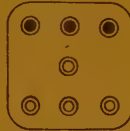
Position light v. semaphore signals.

Position light signal.

Sema-
phore.

NAME.

INDICATION.



Stop signal.

Stop.



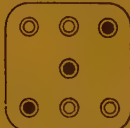
Permissive signal.

Track immediately ahead is occupied. Proceed with caution prepared to stop short of train or obstruction.



Slow speed signal.

Track is set to diverge over slow speed turnout. Track is unoccupied to next signal. Proceed at slow speed prepared to stop.



Caution signal.

Approach next signal prepared to stop.



Clear signal.

Proceed at authorized speed.

Fig. 9. — Five position light signal indications.

5° « clear signal », indicating that the route is lined up, the movement is being made without divergence, the next signal is at caution

or clear and the track is unoccupied at least to the second signal, i. e. authority to proceed at authorised speed.

[636 .257]

8. — The double-wire working of points and signals.

Figs. 10 to 15, pp. 1190 to 1191.

(*Railway Engineer.*)

The wire working of points has many attractions for the signal engineer. Prominent among these is the obvious one of considerably reduced first cost and of future maintenance. But, almost of equal worth, are the extended

limit possible for points to be connected to a box — this readily may be 500 to 600 yards — and the ease of operation. Yet another feature that appeals is the guarantee that the lever has done its work, whilst a minor one

is the provision that ensures that should the points be run through in a trailing direction, when not set to suit, neither the switches nor the point connections are damaged. There are other benefits which we will refer to later; for the moment we are pointing out the leading features.

Double-wire working of signals has advantages that are not as generally known as is desirable. The ease of operation it provides is remarkable and the wires are automatically adjusted and are compensated when the signals are at « clear » just the same as when at « danger ». A very important point is that the signals are restored by definite operation and not by gravity. This ensures that the signal cannot stick « off ».

To many, used to the locking frame resting on the floor of the cabin, the double-wire locking frame may appear objectionable. May we say that, compared with the customary method of operation, this new type is uncommonly easy to work? One hand, usually, will pull over a lever and restore it; there is none of the drag, pull and strain commonly found in locking frames. A stroke of 18 inches is given to the wire. The raised position of the frame allows for the locking troughs to be above floor level and consequently more convenient to the fitter.

Before now proceeding to a description of the system in detail we would give a little explanation of the principle in general. One end of a single wire is attached to and passes over the drum of the lever. It is led out of the lower part of the signal-box and carried on the usual wire posts by the customary pulleys. At the points or signal the wire is passed round an operating pulley and then returns to the box, on posts and pulleys like the outward wire, and there joined to the underside of the drum. The wire thus is continuous, and as the outward wire moves towards the box the return wire travels towards the points or signal and *vice versa*. On the operating pulley at the points or signal is a stud, engaging, for a signal, in a cam on a lower motion plate, and, for points, in an escapement crank. It is this which gives the necessary movement to the points

and signals, and the stud only engages sufficiently long to give the required action to the motion plate or escapement crank.

Operation of points.

There is a variation in detail according as to whether the points are to be trailable or non-trailable. In case any explanation of these two terms would be necessary, we would point out that on passing loops on single lines the points giving access from the loop on to the main line are often trailed through; particularly is this the case where starting signals are not provided. Means must therefore be installed to prevent injury to the point connections when the wheel forces the switch into the necessary route. Some of the previous methods of doing this have been by inserting springs in the connections which automatically open and close as each wheel passes over them. Such points are known as « trailable », and need only be worked when a train movement in the facing direction is made.

In the double-wire trailing-point movement the trailing is accomplished by a reversal of the operating connections. To enable this to be done, the drum to which the wire connections are attached on the locking frame is not rigidly connected to its operating handle, but is located by a special device in the correct synchronising position of drum and handle. When the lever is either full normal or full reverse the trailing of the points actually moves the whole of the operating connections and revolves the drum in the locking frame. Directly this drum moves out of the synchronising position of the handle it causes the interlocking to be fouled, thus preventing any possible chance of a signal lever being pulled over with the points in the incorrect position. The corresponding point lever handle also becomes locked, so that not only is interlocking between this lever and others fouled, but the operating lever itself held immovable. The signalman, however, by the use of a special spanner, is able to reset the drum, after trailing, into its correct synchronising position, when immediately the locking is free as well as the operating handle, and normal working can take place.

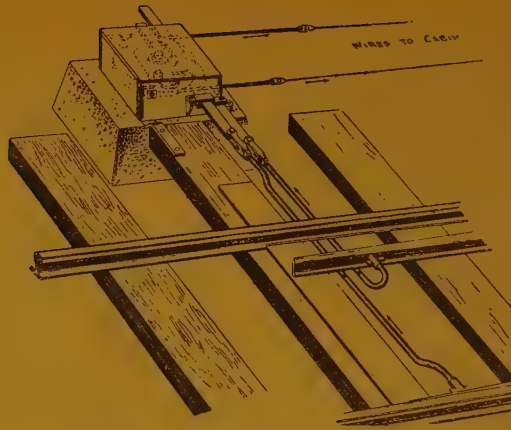


Fig. 10. — Trailable point lay-out.

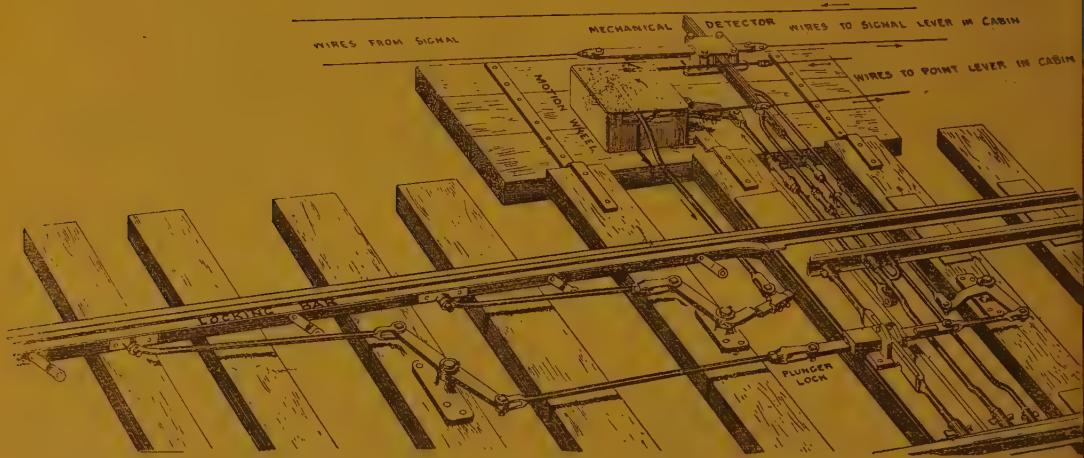


Fig. 11. — Non-trailable point lay-out with mechanical point detector.

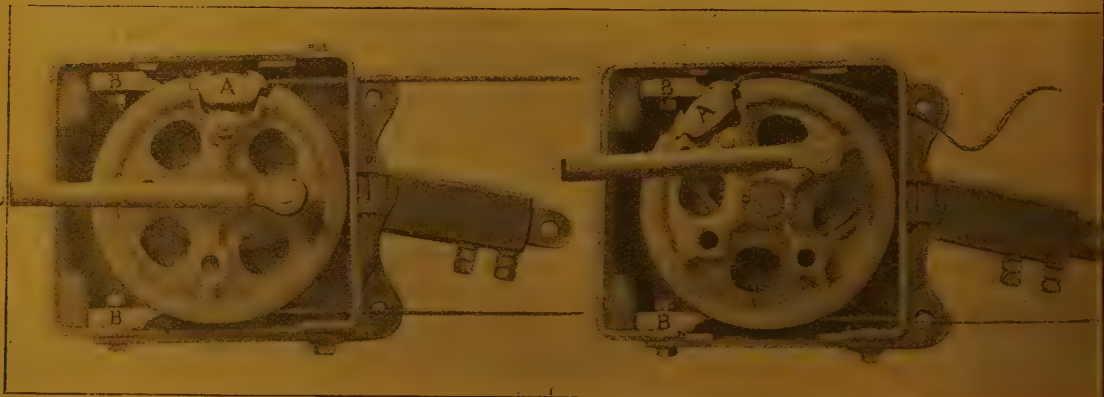


Fig. 12. — Non-trailable point mechanism.



Fig. 13. — Locking frame.



Fig. 14. — Double wire compensator.

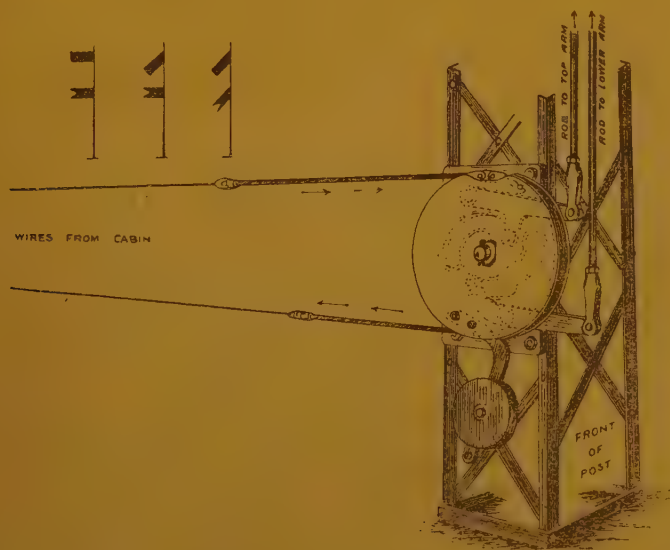


Fig. 15. — Operating pulley in double-lever signal mechanism.

From this description it will be realised that a signalman is immediately advised when any set of points is trailed. Provision is also made for sealing, by means of a lead seal, each operating handle with its correct operating drum, so that a record, by means of broken seals, can be kept of every case of points being trailed.

Figure 10 shows the arrangement of the trailable point lay-out. Each switch has, it will be seen, a separate pull rod, and each is locked when the movement to open or close the switches has been made. For facing points a locking bar is added which, when moved, rises and then falls back to its original position and does not travel through a completed arc. As usual, should there be a vehicle on the bar, it cannot be raised, nor, therefore, the points be moved. In order to prevent the bar being damaged when it is automatically raised by the points being run through, it is so constructed, made of sufficient strength, and having suitable rockers and a spring drive, as readily to be depressed by the first and succeeding wheels. As previously stated, the signalman, by being unable to move the lever, knows that the points have been run through.

Where « trailing » is not considered necessary or advisable for special reasons, a non-trailable point mechanism is available and in this case there is no need for more than one pull rod. From figure 11 it will be seen that every refinement can be given, if necessary. The operating wire nearer to the rails, when pulled, causes the operating pulley to turn in an anticlockwise direction. This first raises the locking bar, which movement withdraws the plunger from the divided stretcher bar. That done, the movement of the bar ceases and that of the points begin. When the switches have been reversed, the bar again moves and the further part of the plunger enters the stretcher bar in its over position. Beyond the point mechanism will be seen a detector in the run of wire to the signal. This detects, it will be noticed, both switches and the plunger. The detectors are specially designed to suit the long stroke of the operating wires. Electrical detection is as readily attached; in fact, all that can be done with rod-

worked points can be done with wire-worked.

To guard against the operating pulley, in the event of one wire breaking, being moved by the tension of the other wire, catches A and B (fig. 12) are provided. The catch A is kept in position by the wire being intact; if the wire broke the catch A would be thrown outwards and come against B, which would hold it. Should the points be reversed the catch A would be on the other side of the case, and a broken wire would then cause it to engage with the other catch B.

Points, even if provided with the economical facing point lock just mentioned, can be satisfactorily worked up to 500 to 600 yards from their operating lever.

Operation of signals.

The same principle puts signals to « clear » and returns them to « danger », and by being provided with overrun at both ends of the cam slot a definite motion is given to the rod to the arm, irrespective of the stroke of the operating connection. Signals, too, are provided with a disconnecting device that disconnects both lengths of wire in the event of a breakage and the arm goes to « danger ».

For countries — *e. g.*, India and the Federated Malay States — that use the « outer » and « warner » signal, a two-lever signal unit has been devised. This is seen on the right in figure 13, where the three other levers are of the usual pattern. Although there are two levers and two signals to be operated, one wire — outward and return — suffices. This wire has 3-foot stroke, instead of 18 inches, and the upper arm is operated before the lower commences to move. Figure 15 shows the operating pulley in this case. The cam seen on the upper left is for the upper arm and the lower right cam is for the lower arm. The stud in the latter does not stir during the first half-movement of the pulley and the other stud does not alter its position in the second half. The same arrangement is applied to a three-position signal. Where this scheme is employed there is a double-wire compensating detector which guarantees that the first movement has been completed before the second is commenced.

Wire compensation.

Figure 14 shows the wire compensator. It is on the floating wire principle, but the wires being, in a sense, continuous, a break in the wire does not permit the compensator to pull off the signal. The two wires are adjusted equally both when the signal is « on » and when « off ». The weights force the rear wheels outwards and so keep the wires taut. The automatic grip only comes into play and holds the weighted levers immovable during the movement of the operating lever.

Locking frame.

A view of the locking frame is given in figure 13. It only remains to be said that, except in the two unit cases, the levers are fixed at 6-inch centres and each lever is a

unit; any type of lever can be interchanged, that is, a signal lever, a non-trailable point lever, or a trailable point lever, and in the case of the first two they are identical, with the exception that on the signal lever the breaking wire device is not operative. Each lever has a number plate for its normal and reverse position.

When a lever is reversed, it is in the position taken up by No. 3 lever in figure 13. The locking trough is fixed behind the levers and above floor level. Where added to an ordinary mechanical frame interlocking between the two frames is readily provided for. Siding locks, electric locks, etc., are easily attached to the front. Each lever is provided with a breaking wire detector, which engages should a wire break, and so prevent the further movement of the lever.

[656 .257 (.42)]

9. — Long-distance point operation.

Figs. 16 to 19, pp. 1194 and 1195.

(*The Railway Gazette.*)

The Limerick branch of the Great Southern & Western Railway enters the Dublin-Cork main line at a point about 1 mile north of Charleville station, as shown in figure 18. The junction was previously worked from an independent box, but this was burnt down. The question of its re-erection having arisen, it was pointed out that this would be unnecessary were the facing points operated from Charleville station box, 1850 yards to the south. It was further recognised that long-distance operation of points is now no longer a novelty. There was, however, a question as to what particular means of operation should be employed. There was, too, a difficulty as to the protection of the main line from Dublin against movements off the branch.

This latter trouble has been met in a novel way. The connection with the down main line, *i. e.*, that from Dublin, shown dotted in the diagram, has been removed, and there is a junction with the up main line only, as shown in figure 16. Trains from Limerick,

when points AA have been reversed and signal B lowered, proceed over the facing road and pass to their proper line by the crossover road 18.18 at Charleville, which is protected by signal 29.30. The whole of the line from signal B to the crossover is track-circuited and that signal cannot be lowered unless the line is unoccupied. These track circuits are arranged to operate as one on the cut-section principle, X₁ relaying X track, and are repeated in the cabin by a repeater relay and indicator, all signal, lock and point control wires being taken through contacts on the repeater relay.

The track circuits X and X₁ control inner homes 3.5. Lever A locks signal 4 and releases signal 6. It is of interest to note that, further, the latter signal cannot be lowered until the electrical train staff for the branch has been obtained from its instrument. The circuit from the hand generator to the points AA is taken over the track repeater relay, and so any movement of the crossover



Fig. 16. — View of junction, looking towards Dublin.



Fig. 17. — View of junction, looking towards Charleville Station.

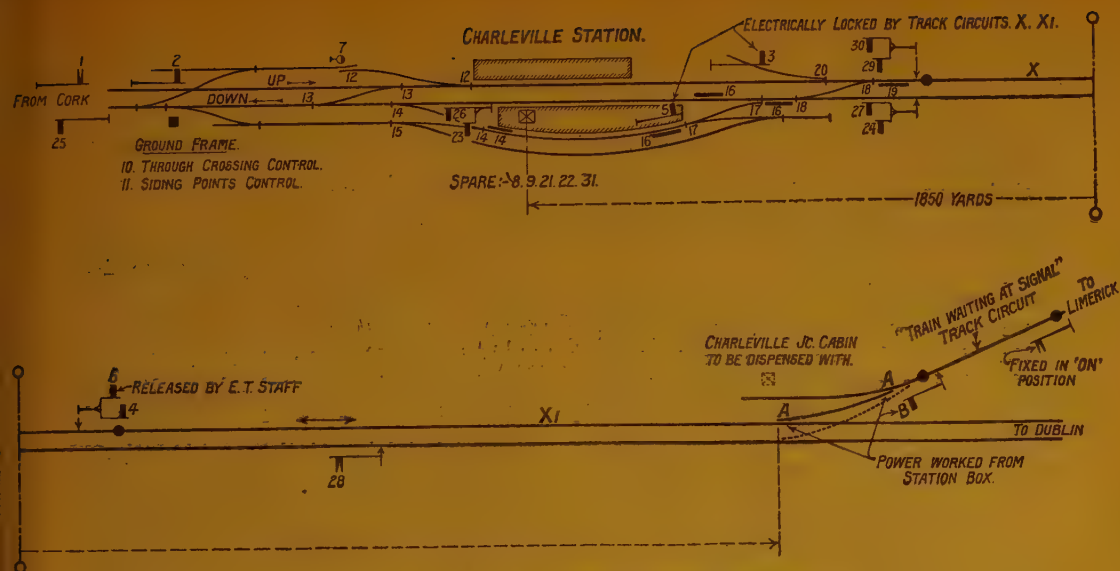


Fig. 18. — Plan of lines as altered, showing signalling, etc.



Fig. 19. — Slide lever-frame and hand-operated generator.

while this track-circuited section of line is occupied is prevented. The levers 4 and 6 are similarly fitted with electric lever locks, the circuits to which are controlled through AA point indication relay.

The hand-generator method used at Charleville was designed by Mr. J. H. Nicholson, the company's Signal Superintendent, and Mr. W. S. Roberts, who, in the development of their idea, sought and obtained the collaboration of the Westinghouse Brake & Saxby Signal Co., Ltd., 82, York Road, King's Cross, N. 1. By the courtesy of all parties we are now enabled to describe what has been done.

The system devised by Messrs. Nicholson and Roberts obtains power through the use of a hand-operated generator placed in the signal-box. This supplies electrical energy at 100 volts direct current to the point and signal machines to be operated. Provision is also made, by means of special circuits, for utilising a small primary battery, also situated in the signal-box, for the holding-clear circuits of the signals, and other purposes.

The use of such a hand generator results in a considerable saving in the number and size of batteries to be installed and maintained, and in the housing normally required for them. The hand generator is driven through a spur-gear train in order to obtain the highest possible electrical output from the manual power available. The normal operating speed of the handle is between 60 and 70 revolutions per minute for 100 volts. The machine is capable of delivering a maximum of 1.2 amperes and is fitted with carbon brushes and facilities for oiling. It is of robust build, totally enclosed in an aluminium case, the approximate dimensions being 8 inches long — exclusive of handle — and 7 inches high.

The point mechanism is similar in type to the Westinghouse machine for low-voltage point operation, but is specially adapted for operation on the hand-generator system. A point worthy of particular note is the polarised control relay which is built into each point machine. The method of operation is as follows: In the signal-box is a two-lever frame of the slide type controlling the circuits for

the points AA and the signal B. Alongside this slide-lever frame is the hand generator, the two together being mounted on a teak cabinet.

To effect the reversal of the points, provided that X and X1 track indicators show « Clear », the signalman pulls the point slide lever to the reverse indication lock position, thereby completing the circuit to the point machine polarised control relays. He then turns the hand generator and reverses the contacts of the two point control relays. The circuit to the point motors having now been completed, he continues to turn the generator until the points have thrown and the motors cut out of circuit. Provided that the points at both ends of the connection are fully reversed, the circuit to the reverse indication lock is completed through the point detectors, and the slide lever can now be pulled to the full reverse position.

Assuming that X and X1 track indicators still show « Clear », the signal slide lever can now be pulled over and the circuit completed from the hand generator to a bridging contact relay. The generator is then operated and the relay energised, the current being taken over the relay arm up, over X and X1 repeater relay, and over the point indication relay reversed, to the signal machine on signal B, which is a standard Westinghouse motor. Immediately the signal reaches the « off » position, the circuit to the signal motor is interrupted by the cut-out in the machine. The circuit from the generator to the machine clutch coils, however, is still maintained, being in parallel with the signal motor winding. The operation of the hand generator is now discontinued, and as soon as the voltage impressed thereby upon the bridging contact relay falls to a predetermined value, due to the reduction in speed of the generator armature, the relay arm falls, but makes its bottom contact before breaking the top, and so completes a circuit from the 10-volt battery in the box to the signal machine, thereby maintaining a feed on the clutch coils of the machine, and holding the signal in the « off » position. The restoration of the signal-slide lever to normal, or the entrance of a train into

X and X₁ track section, breaks the battery circuit and thus de-energises the clutch coils of the machine, permitting the signal to return to « danger ». To restore the points to normal, the sequence of operations above described would, of course, be repeated in the reverse order.

The time required to change the points is 7 seconds, which, it should be noted, is only about half that required for reversing similar points fitted with low-voltage battery point machines. Some idea of the electrical efficiency may be gathered when it is stated that both ends of the connection are fitted with facing-point locks. Track locking of the point lever is provided and locking bars thereby dispensed with; the same locks are used for

point indication as are used for this purpose.

As has already been said, the mechanically operated signals 3 and 5 are fitted with electric lever locks for the track-locking of these levers by X and X₁ track circuits. These are of the Westinghouse type. Levers 4 and 6 are similarly fitted with electric lever locks, controlled by AA point detection relay.

Special provision has been made for mechanical locking between slides A and B in the slide lever frame and the locking of the main mechanical interlocking apparatus. Small down rods actuated from a cam-path in the slide levers drive tappets in the locking troughs of the mechanical frame, these down rods being totally enclosed in the teak cabinet on which the slide lever frame is mounted.

OBITUARY

C. A. L. M. DASSESSE,

Honorary Inspector General of the Belgian State Railways;
Reporter to the Paris (1900) and Berne (1910), sessions of the International Railway Congress.

We have learned with deep regret of the death of Mr. Charles Dasselssse, one of our oldest and most respected colleagues and one who had always taken the greatest interest in our work.

His decease will be deeply felt in the Belgian Administration where he was universally beloved, and in the railway world generally in which he had endeared himself to many friends.

It is scarcely two years since, having reached the age limit, he retired from service, but still dealt with questions on which his advice was asked up to the time when, to the sorrow of his friends, he passed away.

Leaving the School of Mines at Liège with the honorary degree of Engineer of Mines, Mr. Dasselssse entered the service of the Belgian State Railways as an assistant engineer in 1880. Shortly afterwards, being given charge of an important locomotive depot, he very quickly displayed his talent for organisation, which he shewed under difficult circumstances. About a year and a half afterwards he was transferred to the headquarters of the rolling stock department, which he never afterwards left. He had a successful career for more than 40 years, during which time he devoted himself, with the greatest success, to the study of traction questions, as well as to the solution of various problems con-

nected with the construction, use and maintenance of locomotives.

At first attached to the rolling stock office, and afterwards chief of this office, he had to organise the absorption of various companies into the State railway system. Following this, his energy was directed to the study of questions dealing with rolling stock. He took part in all the work dealing with the improvement and perfecting of locomotives, the rebuilding of existing types and the production of new designs. Endowed with a very sound judgment, clear sighted with regard to innovations, he was an energetic and intelligent collaborator of those upon whom the responsibility of the rolling stock departement rested. He was many times the recipient of marks of appreciation of his services.

Mr. Dasselssse was conversant with all the phases of locomotive development which have taken place during the past half century. He had taken part in all the work which so transformed the Belgian stock. Equipped with a sound knowledge of engineering science, given to the investigation and study of improvements introduced elsewhere, he had attained a high position in his profession.

Those who have followed the work of the Congress will call to mind the remarkable reports which he wrote for the

Paris session in 1900 and for that at Berne in 1910. The first of these was on the stability of locomotive axles, and the second on the improvements in locomotive boilers. They are the work of a methodical mind, endeavouring to find a path of progress by the light of carefully recorded facts. The last report especially came at a time when eminent engineers were seeking enlightenment on a subject still controversial, and it was a document of the greatest value. It laid before the Congress a faithful record of the magnificent results obtained in Belgium by the use of superheated steam. It was in Belgium that, owing to the acumen of the late Mr. J. B. Flamme, this improvement, now in general use, in its early days of its present application was rapidly adopted.

The war struck Mr. Dasselès very deeply, but he soon overcame its effects by his energy and courage. During the occupation of Belgium he was able, in spite of great danger, to assist the cause of the Allies, and for the valuable services he rendered he was awarded the British War Medal and was appointed an Honorary Member of the Military Division of the Most Excellent Order of the British Empire.

After the armistice he took up again, with renewed activity, the charge of the locomotive service, and was amongst the most devoted of those who, in spite of innumerable difficulties, carried out the restoration of the devastated railroad. It was also under his clear direction that the question of the new locomotives to

be acquired by the Belgian State Railways, for the restoration and improvement of its stock, was worked out.

Mr. Dasselès was beloved and esteemed by all his colleagues. In character he was firm but affable; the consideration and kindness he ever shewed towards those who worked with and for him gained for him the respect and esteem of the whole of the staff.

After his retirement, he was, on account of his great experience in matters and questions of administration, made a member of the Main Committee of Control. The advice he gave was always listened to with attention, and the reports he presented, which were always most carefully drawn up, were very greatly appreciated. He was for a long time a member of the Permanent Commission on steam appliances.

Mr. Dasselès was a member of the special commission appointed to adjudicate in the competition for the triennial Arthur Dubois prize 1920-1922, a prize which has been instituted by the Permanent Commission of the Railway Congress to perpetuate the memory of its late President.

He was a Commander of the Crown, an Officer to the Order of Leopold with « liserés d'or », he held the Civic Crown 1^{re} Order, and the Commemoration Medal of H. S. H. Leopold II.

We offer to his family the condolence we feel for them at their loss, and assure them of our sincere sympathy.

The Executive Committee.

Brigadier-General Sir HUGH W. DRUMMOND, Bart., C. M. G.,

Chairman of the Southern Railway of England;

Delegate to the sessions of the International Railway Congress at Paris (1900),

Washington (1905), Berne (1910) and Rome (1922);

Member of the English Local Commission of Organisation for the tenth session (London, 1925).

We have heard with deep regret of the death of Sir Hugh Drummond, Chairman of the Southern Railway of England, and a member of the English Commission of Organisation for the Congress which will be held in London in June 1925.

Sir Hugh Drummond was born at Clovelly Court, North Devon, in 1859.

He was associated with numerous important business enterprises. At the time of his death, in addition to his position of Chairman of the Southern Railway, he was a Director of the National Provincial & Union Bank of England, Deputy Chairman of the Alliance Assurance Company, a Director of the British-Italian Corporation, Limited, the London & Brazilian Bank, Limited, and the Shell Transport & Trading Co., Limited. His great business qualities and talent for organisation were well known.

Before becoming a Director of the London & South Western Railway, General Drummond had taken an active part in the independent company which constructed the Budleigh Salterton line. In 1900 he became a Director of the London & South Western Railway, and at once gained the confidence of his colleagues. In 1904, when Colonel Campbell retired from the Chairmanship of the Railway and was succeeded by Sir Charles Scotter, he was unanimously elected Deputy Chairman, which position he held until 1910, when upon the death of Sir Charles Scotter, Sir Hugh was appointed Chairman in his place. He occupied this position until 1922, when upon the Railway Act coming into operation, the London & South Western Railway ceased to exist as an independent Company, being absorbed in the group which formed the Southern Railway, of which Sir Hugh Drummond became the first Chairman of the new group.

Under his Chairmanship of the «South Western», the Company carried out the electrified suburban service which has proved such an unqualified success and which contributed so largely to its prosperity. In March last, the Company was honoured with the presence of Her Majesty the Queen, who, on behalf of His Majesty the King, formally opened the new Waterloo Station, which is looked upon as the largest, finest and best equipped station of its kind in Great Britain. It was largely due to Sir Hugh that this rebuilding was accelerated so that it was able to accommodate the immense naval and military traffic which used the line throughout the war. This year he had the satisfaction of seeing the largest passenger vessels afloat using the Port of Southampton, and from this port it is now possible to embark for almost any part of the world. The enormous development of this property was in no small degree due to his ability and enterprise.

During the past few months, it was evident that his hitherto vigorous health was failing, and without doubt he felt the strain of the many and anxious problems connected with the amalgamation.

A keen administrator, he was also a true friend to the railway staff and never failed to recognise good work done; his loss will be keenly felt by the Directors and Staff throughout the Southern Railway service and to all others who had met him and to whom he was endeared by his genial courtesy.

We offer to the family of our esteemed colleague our deep sympathy and sincere condolence with them in their loss.

The Executive Committee.

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MONTHLY BIBLIOGRAPHY OF RAILWAYS ⁽¹⁾

PUBLISHED UNDER THE SUPERVISION OF

J. VERDEYEN,

General secretary of the Permanent Commission of the International Railway Congress Association.

[016 .385. (02)]

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In French.	In English.
1923 313 .385 (.494) DÉPARTEMENT FÉDÉRAL DES POSTES ET DES CHEMINS DE FER SUISSES. Statistique des chemins de fer suisses pour les années 1920 et 1921. Berne.	1923 697. (02) COLEMAN (G. S.). Calculations in heating and ventilation. New York, Longmans, Green & Co. (9×6 inches), 255 pages, diagrams & tables. (Price : \$5.00.).
1923 621 .31 (02) KLINGENBERG (G.), docteur-ingénieur, professeur à l'Ecole technique supérieure de Berlin. Construction des grandes stations centrales électriques. Traduit de l'allemand par Adolphe Vogel, ingénieur des constructions civiles. Paris (VI*), rue des Saints-Pères, 15; Liège, rue des Dominicains, 8, Librairie polytechnique Ch. Béranger. In-4° (220×280), 505 pages, avec de nombreuses figures dans le texte et 13 planches hors texte. (Prix : 95 fr.)	1923 62. (02) FISH (J. C. L.), professor of railroad engineering, Leeland Stanford University. Engineering economics. New York, McGraw-Hill Book Company. (6×9 inches), 312 pages, tables and charts. Bound in cloth.
1923 625 .142 .4 Les traverses et supports de voie en béton armé. Système Vagneux, breveté en tous pays. Dijon, impr. Jobard. In-4°, 39 pages et planches.	1923 669 .1 (02) HARBORD (F. W.) & HALL (J. W.). The metallurgy of steel. — Vol. II. Mechanical treatment, by J. W. Hall. London, W. C. 2, Charles Griffin and Co., Exeter street, Strand 8th, xiv-553 pages & 399 fig.
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(1) The numbers placed over the title of each book are those of the decimal classification proposed by the Railway Congress conjointly with the Office Bibliographique International, of Brussels. (See "Bibliographical Decimal Classification as applied to Railway Science," by L. WEISSENBRUCH, in the number for November, 1897, of the *Bulletin of the International Railway Congress*, p. 1509.)

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PARODI. — Electrification partielle des chemins de fer français. (21 600 mots & fig.)

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FERET (R.). — Recherches sur la meilleure composition des mortiers et des bétons hydrauliques. (9 000 mots, 6 tableaux & fig.)

1923 69
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LACORE (A.). — Considérations générales pour procéder à l'installation d'une usine de ciment Portland artificiel moderne. (8 000 mots & fig.)

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HAAR (S.). — Modern subway cars and their operation. (5 300 words & fig.)

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Railway Age, No. 18, November 3, p. 821.
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Two-car motor train for the Mississippi Central. (900 words & fig.)

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Possibilities of half stroke cut-off locomotive. (2 700 words & fig.)

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Dynamometer car used on the Great Western Railway. (2 400 words & fig.)

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Automatic operation of railway points. (1 700 words & fig.)

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1923 621 .95 (.42)
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Vertical boring and turning mills in locomotive, carriage and wagon works. (2 000 words & fig.)

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Shop reorganisation at Swindon works, Great Western Railway. (2 600 words & fig.)

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- 1923 621 .132.3 (.73)
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- 1923 621 .131.1 (.73)
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- 1923 656 .222.1 (.42)
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 The Ford plan of employee participation. (2300 words.)
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1923

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 MAFFEZZOLI (A.). — Sulla caratteristica meccanica delle locomotive e sulle curve di accelerazione. (2100 parole & fig.)

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 Construccion de lineas ferroviarias por el Estado. (12000 palabras, 5 cuadros & fig.)

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 DE KOCK VAN LEEUWEN (W. J.). — Een onjuiste evenwichtsberekening van ophaalbruggen. (1300 woorden & fig.)



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[016 .385. (02)]

I. — BOOKS.

In French.

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UCAMUS (E.) & MOREAU (Auguste), ingénieurs des arts et manufactures.
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 Tours, impr. Deslis père, R. et P. Deslis; Paris (VI^e), Dumod, éditeur, 47 et 49, quai des Grands-Augustins. -16, x-384 pages avec fig.

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 Paris (VI^e), Dunod, éditeur, 92, rue Bonaparte. -fol. non paginé.

1923 621 .131. (02)
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Le monteur-mécanicien des chemins de fer. Préface de M. LACON, ingénieur en chef du matériel et de la traction de la Compagnie d'Orléans. 1^{er} volume : Technologie de la locomotive.
 Vannes, impr. Lafolye frères & C^{ie}; Paris, Léon Vayrolles, libr.-éditeur, 5, rue Thénard. In-16, 232 pages fig.

1923 624. (02)
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Ponts et combles métalliques.
 Paris, J.-B. Baillière & fils, 667 pages, avec de nombreuses figures.

1923 621 .137.1 (02)
ALLEUX (François), inspecteur de la traction et du matériel à la Société nationale des chemins de fer vicinaux belges.

Manuel du mécanicien des chemins de fer vicinaux d'intérêt local.
 Bruxelles, Ramlot frères & sœur; Paris, H. Dunod et P. Pinat. (210 × 155), 782 pages, illust. (Prix : 25 fr.)

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VARINOIS (Maurice), ingénieur des arts et manufactures.

Le fraisage. La fraise. Les machines à fraiser. Les machines à tailler. Les engrenages. Exemples de travaux de fraisage.

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 Warschau, Eisenbahnministerium (Ausgabe 1923) im Masstab von 1: 250 000; 4 Blätter.

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Allgemeine Maschinenlehre.
 Leipzig, Verlag von Otto Spamer. Mit 200 Abb. (Preis, Gz. : 9.)

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NORDMANN (Hans), Reg.-Baurat beim Eisenbahnzentralamt in Berlin.
Die Schule des Locomotivführers. Von Brosius & Koch.

Berlin, C. W. Kreidel's Verlag, 14, neu bearbeitete Auflage. 1. Abteilung mit 246 Textabb. (Preis, Gz. : 3.50 Mark.)

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 London, S. W. 1, The Railway Publishing Co., Ltd.
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MONTHLY BIBLIOGRAPHY OF RAILWAYS ⁽¹⁾

PUBLISHED UNDER THE SUPERVISION OF

J. VERDEYEN,

General secretary of the Permanent Commission of the International Railway Congress Association.

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 Mikado type locomotive, Canadian National Rys.
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MONTHLY BIBLIOGRAPHY OF RAILWAYS⁽¹⁾

PUBLISHED UNDER THE SUPERVISION OF

J. VERDEYEN,

General secretary of the Permanent Commission of the International Railway Congress Association.

[016 .385. (02)]

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(1) The numbers placed over the title of each book are those of the decimal classification proposed by the Railway Congress conjointly with the Office Bibliographique International, of Brussels. (See « Bibliographical Decimal Classification as applied to Railway Science », by L. WEISSENBRUCH, in the number for November, 1897, of the *Bulletin of the International Railway Congress*, p. 1509.)

1923 385 .3 (08 (.73))
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MARCOTTE (E.). — Nouveaux procédés pour combattre l'usure des rails et des bandages de roues. (9 000 mots, 3 tableaux & fig.)

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SAVARY (E.). — Les locomotives électriques type 1-C-1 des chemins de fer fédéraux. (1 700 mots & fig.)
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DUMAS (A.). — L'élasticité du béton. (1 700 mots & fig.)

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MOLITOR (C.). — Calcul de l'arc à deux rotules équilibré par un chaînage polygonal. (3 300 mots & fig.)
1924 621 .94
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CALFAS (P.). — Les cités-jardins de la Compagnie du chemin de fer du Nord. (3 000 mots & fig.)

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DURAND (J.). — Détermination industrielle de la limite élastique des aciers. (2 800 mots & fig.)

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ANDRY-BOURGEOIS. — Le tirage mécanique appliqué aux foyers des locomotives. (2 800 mots & fig.)

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DEWAEY (E.). — La fatigue des matériaux. (3 600 mots & fig.)

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ALBAGNAC. — Nouvelle méthode d'entretien des voies sur les lignes secondaires du réseau de Paris à Orléans. (7 600 mots & fig.)
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ADAM. — Utilisation de traverses en béton de ciment armé pour l'entretien des voies des lignes secondaires. (2 500 mots & fig.)
1924 656 .251 (.44) & 656 .256.3 (.44)
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LEMONNIER (A.). — Block automatique à signaux lumineux mis à l'essai par les chemins de fer de l'Etat sur la ligne de Paris à Saint-Germain. (3 200 mots & fig.)
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SAUTER. — Die Gesetzgebung Italiens auf dem Gebiet des Eisenbahnwesens seit 1915. (5 000 Wörter.)

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Die Eisenbahnen in Britisch-Indien 1921-22. (Tabellen.)

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KUHASHHECK (O.). — Die Arbeiterpensionskassen, die Krankenkassen und die Unfallversicherung bei der Deutschen Reichsbahn seit dem Jahre 1920. (6 600 Wörter & Tabellen.)

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Die Holländischen Eisenbahnen im Jahr 1922. (2 700 Wörter & 6 Tabellen.)

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Die Schwedischen Staatseisenbahnen 1921. (7 Tabellen.)

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Die Eisenbahnen in Norwegen in den Jahren 1920-21 und 1921-22. (Tabellen.)

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Report of Committee III-Ties. (5 300 words, 12 table & fig.)

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Bull. Amer. Ry. Eng. Ass^{on}, November, p. 159.
Report of Committee XIII. — Water service. (14 000 words & fig.)

1923 624. (01 (.73) & 625 .154. (01 (.73)
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Report of Committee XV : Iron and steel structures (20 000 words & fig.)

1923 621 .33 (.73)
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Report of Committee XVIII : Electricity. (9 200 words & fig.)

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Report of Committee IV : Rail. (9 400 words, table & fig.)

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Report of Committee V : Track. (18 000 words & fig.)

1924 656 .211 & 656 .212
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Report of Committee XIV : Yards and terminals (42 300 words, 7 tables & fig.)

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Report of Committee XII : Rules and organization (37 000 words & fig.)

Electric Railway Journal. (New York.)

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Pennsylvania Railroad builds three experimental locomotives. (1 400 words & fig.)

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Electric Railway Journal, No. 6, February 9, p. 217.
Railroad transportation features A. I. E. E. meeting. (2 400 words & fig.)

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New features of St. Louis automatics. (2 700 words & fig.)

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Double-bogie petrol rail car for Barbadoes. (600 words & fig.)

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Engineer, No. 3554, February 8, p. 156.

GRESLEY (H. N.). — London & North-Eastern Railway : booster locomotive. (400 words & fig.)

1924 621 .338 (.42) & 625 .26 (.42)
Engineer, No. 3555, February 15, p. 173.

The Acton Works of the underground railways. (2 500 words & fig.)

1924 621 .132.5 (.54)
Engineer, No. 3555, February 15, p. 184.

North Western Railway of India, eight-coupled goods engine. (100 words & fig.)

1924 621 .133.3
Engineer, No. 3556, February 22, p. 192.

POULTNEY (E. C.). — Locomotive boiler performance. (4 500 words & fig.)

1924 621 .133.1
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Oil locomotives. (1 600 words.)

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Development railways. (1 700 words.)

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Car repair shops of the London Underground Railways at Acton. (7 300 words & fig.)

1924 624. (01)
Engineering, No. 3033, February 15, p. 209.

Secondary stresses. (2 300 words.)

1924 656 .1 & 656 .2
Engineering, No. 3034, February 22, p. 234.

Transport by road and rail. (5 200 words.)

Engineering News-Record. (New York.)

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Engineering News Record, No. 4, January 24, p. 150.

Through-truss spans converted to deck girder viaduct. 2 000 words & fig.)

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Engineering News Record, No. 5, January 31, p. 186.

Progress on the Union Station at St-Paul, Minn. 1 300 words & fig.)

1924 621 .332 (.44)
Engineering, No. 5, January 31, p. 208.
Third-rail electrification for P. L. M. Ry. in France. (1 000 words & fig.)

1924 624 .63 (.73)
Engineering News Record, No. 8, February 21, p. 320.

HARDER (E. H.). — Building a concrete arch around an old bridge. (2 200 words & fig.)

1924 725 .35 (.73)
Engineering News Record, No. 8, February 21, p. 324.

Large terminal and cold-storage warehouse at Duluth. (3 300 words & fig.)

Journal, Permanent Way Institution. (London.)

1923 656 .254
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THORROWGOOD (W. J.). — Automatic telephones for railway working. (4 700 words & fig.)

1923 625 .143.5
Journal, Perm. Way Inst., December, p. 272.

STUART (A. R.). — Fastening rails to sleepers. (7 400 words & fig.)

Journal of the Western Society of Engineers. (Chicago.)

1924 725 .31 (.73)
Journal Western Society of Engineers, January, p. 13.

FILIPPI (H.). — Moving the seven story Dowie building. (3 000 words & fig.)

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1924 621 .135.2 & 625 .214
Mechanical Engineering, February, p. 77.

HOWARTH (H. A. S.). — A graphical study of journal lubrication. (3 200 words & fig.)

Modern transport. (London.)

1924 624 .52 (.94)
Modern transport, No. 256, February 9, p. 10.

Proposed bridge across Sydney harbour. (1 800 words & fig.)

1924 621 .132.8 (.42)
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Steam coaches for rail passenger transport. (1 600 words & fig.)

Proceedings, American Society of Civil Engineers. (New York.)

1924 624 .63
Proceed. Amer. Soc. Civil Eng., February, p. 133.

RATHBUN (J. C.). — Analysis of the stresses in the ring of a concrete skew arch. (7 000 words, 6 tables & fig.)

Proceedings, Institution of Civil Engineers. (London.)

1923 624 .2
Proceed., Institut. of Civil Eng., Vol. CCXVI, Dec., p. 3.

REMFREY (D. H.). — Wind-pressures, and stresses caused by the wind on bridges. (8 000 words, 8 tables & fig.)

Railway Age. (New York.)

1924 625 .142.2 (.73) & 691 (.73)
Railway Age, No. 3, January 19, p. 233.
Wood preservers show economy of treatment. (2 300 words, 1 table & fig.)

1924 625 .111 (.73) & 625 .113 (.73)
Railway Age, No. 4, January 26, p. 275.
Frisco makes important line improvements. (2 600 words & fig.)

1924 621 .138.2 (.73)
Railway Age, No. 4, January 26, p. 297.
A combined cinder and coal hoist. (500 words & fig.)

1924 656 .222.6 (.73)
Railway Age, No. 5, February 2, p. 319.
Utilizing the motor truck in freight traffic. (4 400 words & fig.)

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Railway Age, No. 5, February 2, p. 329.
Canadian National high power motor coach. (1 400 words & fig.)

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Railway Age, No. 5, February 2, p. 337.
LAMB (D. R.). — England's first reinforced concrete enginehouse. (2 200 words & fig.)

1924 621 .132.3 (.73)
Railway Age, No. 6, February 9, p. 375.
Heavy 4-8-2 type Southern Pacific locomotives. (2 300 words, 1 table & fig.)

1924 621 .13 (.73) & 621 .335 (.73)
Railway Age, No. 6, February 9, p. 384.
A. I. E. E. holds transportation meeting. (3 300 words & fig.)

Railway Engineering & Maintenance. (Chicago.)

1924 625 .111 (.73)
Railway Engineering and Maintenance, February, p. 46.
Keeping down maintenance costs at highway crossings. (3 400 words.)

1924 625 .142.2 (.73) & 691 (.73)
Railway Engineering and Maintenance, February, p. 58.
Wood preservers discuss economies of timber treatment. (5 900 words, tables & fig.)

Railway Gazette & Railway News. (London.)

1924 656 .221
Railway Gazette & News, No. 5, February 1, p. 135.
The resistance of express trains. (2 400 words.)

1924 656 .257 (.44)
Railway Gazette & News, No. 5, February 1, p. 137.
Point operation at marshalling yards. (2 400 words & fig.)

1924 621 .132.5 (.43)
Railway Gazette & News, No. 5, February 1, p. 143.
New 3-cylinder, 2-8-2 type locomotive, German State Railways. (500 words & fig.)

1924 625 .243 (.68)
Railway Gazette & News, No. 6, February 8, p. 167.
New 40-ton bogie wagons for South African Railways. (200 words & fig.)

1924 621 .136.3 (.42)
Railway Gazette & News, No. 6, February 8, p. 169.
Water troughs on the Great Western Railway. (60 words & fig.)

1924 621 .132.5 (.54)
Railway Gazette & News, No. 6, February 8, p. 173.
New 2-8-2 type locomotives for the Sudan Government Railways. (400 words & fig.)

1924 621 .132.8 (.43)
Railway Gazette & News, No. 6, February 8, p. 174.
A modern rack locomotive. (300 words & fig.)

1924 621 .338 (.42) & 625 .26 (.42)
Railway Gazette & News, No. 7, February 15, p. 195.
The Acton overhaul works of the underground railways. (3 900 words & fig.)

1924 656 .256.2 (.42)
Railway Gazette & News, No. 7, February 15, p. 203.
The « Syx » improved electric lock-and-block system. (1 500 words & fig.)

1924 621 .132.8 (.42)
Railway Gazette & News, No. 7, February 15, p. 206.
The first « Garratt » locomotive in Great Britain. (650 words & fig.)

1924 621 .335 (.83)
Railway Gazette & News, No. 7, February 15, p. 208.
Westinghouse electric locomotives for the Chilean Railways. (300 words & fig.)

1924 385. (09.1) (.51)
Railway Gazette & News, No. 8, February 22, p. 234.
The Peking-Mukden Railway. (2 400 words & fig.)

1924 385. (09.1) (.54)
Railway Gazette & News, No. 9, February 29, p. 266.
HIGHT (Sir Robert). — The East Indian Railway its construction and development. (6 500 words & fig.)

1924 621 .132.8 (.42) & 625 .61 (.42)
Railway Gazette & News, No. 9, February 29, p. 277.
The « Sentinel-Cammell » steam rail coach in service. (1 400 words & fig.)

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1924 656 .222.1 (.42)
Railway Magazine, March, p. 185.
ALLEN (C. J.). — British locomotive practice and performance. (4 700 words & fig.)

Railway Mechanical Engineer. (New York.)

1924 621 .132.5 (.73)
Railway Mechanical Engineer, February, p. 73.
Heavy 2-10-2 type locomotives for B. & O. (1 700 words, table & fig.)

Railway Review. (Chicago.)

1924 625 .26 (.73)
Railway Review, No. 3, January 19, p. 133.
ARMSTRONG (G. W.). — Systematic car repair work
Kent, Ohio. (1 600 words & fig.)

1924 625 .13 (.73)
Railway Review, No. 3, January 19, p. 140.
BRATE (T. H.). — Rogers Park track elevation,
M. & St. P. Ry. (2 700 words & fig.)

1924 625 .142.2 (.73)
Railway Review, No. 3, January 19, p. 146.
LINE (M. E.). — Cross tie conditions on the
Atlantic coast. (3 200 words.)

1924 621 .132.1 (.73)
Railway Review, No. 4, January 26, p. 167.
Designing locomotives for service requirements. (2 000
words, tables & fig.)

1924 625 .13 (.73)
Railway Review, No. 4, January 26, p. 174.
Country's longest tunnel project well under way.
(1 000 words & fig.)

1924 625 .244 (.73)
Railway Review, No. 4, January 26, p. 182.
Economic thickness of insulation in refrigerator
cars. (4 800 words & fig.)

1924 621 .131.1 (.73) & 621 .136.1 (.73)
Railway Review, No. 5, February 2, p. 203.
REDLES (A. C.). — Long locomotive runs on the
Herk & Western Ry. (1 500 words & fig.)

1924 621 .131.1 & 656 .222.4
Railway Review, No. 5, February 2, p. 209.
MART (V. L.). — The preparation and use of velo-
graphs (Tractive effort, coal consumption and
running time). (3 600 words, 3 tables & fig.)

1924 625 .144.4 (.73)
Railway Review, No. 5, February 2, p. 216.
Photographic chart illustrates standard method of
cutting. (800 words & fig.)

1924 656 .222.6 (.73)
Railway Review, No. 5, February 2, p. 218.
Motor trucks auxiliary to L. C. L. service. (4 400
words.)

1924 621 .132.3 (.73)
Railway Review, No. 6, February 9, p. 250.
8-2 locomotive for long passenger runs. (3 000
words, tables & fig.)

1924 621 .138.1 (.73)
Railway Review, No. 7, February 16, p. 279.
New engine terminal at Peach Creek, W. Va. (4 700
words & fig.)

1924 625 .234
Railway Review, No. 7, February 16, p. 293.
NYSTROM (K. F.). — Ventilation and heating of
railway passenger cars. (5 900 words, 2 tables & fig.)

Railway signaling. (Chicago.)

1924 656 .253 (.73)
Railway Signaling, February, p. 60.
KELLENBERGER (K. E.). — Development of rail-
way signaling. (4 300 words & fig.)

In Italian.

Giornale del genio civile. (Roma.)

1923 624 .52 (.45)
Giornale del genio civile, dicembre, p. 796.
Il ponte sul Po alla Gerola (Pavia). (1 200 parole
& fig.)

Rivista tecnica delle ferrovie italiane. (Roma.)

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necchia delle Ferrovie dello Stato. (4 300 parole & fig.)

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(1 400 palavras.)

MONTHLY BIBLIOGRAPHY OF RAILWAYS⁽¹⁾

PUBLISHED UNDER THE SUPERVISION OF

J. VERDEYEN,

General secretary of the Permanent Commission of the International Railway Congress Association.

[016 .385. (02)]

I. — BOOKS.

In French.		In German.	
1924	531. (02)	1923	621 .94. (02)
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ords & fig.)

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Two light Mikado locomotives built at Lima. (1 100
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fig.)

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PUBLISHED UNDER THE SUPERVISION OF

J. VERDEYEN,

General secretary of the Permanent Commission of the International Railway Congress Association.

[016 .385. (02)]

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 Facilities for fuel oil for locomotives. (4 300 words
 & fig.)

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 Railway Review, No. 14, April 5, p. 631.
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 Train control air devices improved. (2 000 words & fig.)

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691 & 721

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PUBLISHED UNDER THE SUPERVISION OF

J. VERDEYEN,

General secretary of the Permanent Commission of the International Railway Congress Association.

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 The Russian Railway situation. (3 500 words & fig.)

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PUBLISHED UNDER THE SUPERVISION OF

J. VERDEYEN,

General secretary of the Permanent Commission of the International Railway Congress Association.

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1924 621 .116. (02)
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Paris (VI^e), J.-B. Baillière & fils, éditeurs, 19, rue
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- 1924 385.113 (.43 + .47)
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- 1924 621.133.7 (.436)
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CHAPELON (A.). — Etat actuel de la traction à vapeur. (4 400 mots.)

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Electric Railway Journal, No. 23, June 7, p. 881.

HERSHBERGER (D. C.). — Power distribution system of Chilean State Railways electrification. (6 000 words & fig.)

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Details of new Pennsylvania electric locomotives. (700 words & fig.)

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DAWSON (Sir Philip) & PARKER SMITH (S.). — Main line railway electrification. (4 900 words, tables & fig.)

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Electrical engineering exhibits. (2 000 words & fig.)

1924 621 .132 .5 (.73)
Engineer, No. 3572, June 13, p. 666.

American three-cylinder locomotives. (2 300 words, 5 tables & fig.)

1924 621 .134.3 (.42)
Engineer, No. 3574, June 27, p. 706.

Beames-Walschaerts valve gear for inside cylinders. (500 words & fig.)

1924 621 .131.2 (.73)
Engineer, No. 3574, June 27, p. 720.

American locomotive practice. (1 000 words.)

1924 385. (09.3 (.42)
Engineer, No. 3575, July 4, p. 15.

The railway centenary. (2 200 words.)

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Engineer, No. 3575, July 4, p. 17.

One hundred years of British railways. (3 000 words.)

1924 621 .132.8 (.42)
Engineer, No. 3576, July 11, p. 55.

A new rack locomotive. (1 300 words & fig.)

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1924 621 .132.8 (.42)
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The standardisation of boiler testing. (2 200 words & fig.)

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1924 625 .13 (.73)
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Types of turntable developed for heavier locomotives. (2 700 words & fig.)

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Wheel guiding flange frogs for St-Louis Terminal. (650 words & fig.)

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WADDELL (J. A. L.). — The vertical lift bridge.
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SYKES (W. E.). — British machine-tool design.
5 500 words & fig.)

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way. (1 300 words, tables & fig.)

1924 621 .43 (.45) & 621 .132.8 (.45)
Modern Transport, No. 273, June 7, p. 4.
The petrol rail car in Italy. (1 500 words & fig.)

1924 656 .222.6 (.42)
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GRIFFITHS (H. R.). — Freight train formations.
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ords & fig.)

1924 625 .616 (.54)
Modern Transport, No. 274, June 14, p. 3.
« Mallet » articulated compound locomotives for the
urma Railways. (1 500 words & fig.)

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Modern Transport, No. 277, July 5, p. 11.
British-built electric locomotive for Western Australia
overnment Railways. (2 000 words & fig.)

1924 621 .132.5 (.82)
Modern Transport, No. 278, July 12, p. 3.
New type oil fuel burning locomotives, Buenos Aires
reat Southern Railway. (950 words & fig.)

1924 621 .33
Modern Transport, No. 278, July 12, p. 5.
Railway electrification (World Power Conference).
5 300 words.)

Railway Age. (New York.)

1924 656 .256.3 (.73)
Railway Age, No. 25, May 24, p. 1260.
New signals on Burlington expedite traffic. (2 000
ords & fig.)

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Railway Age, No. 25, May 24, p. 1267.
Electric traction exhibit held at Erie, Pa. (1 800 words
fig.)

1924 313 : 625 (.73)
Railway Age, No. 25, May 24, p. 1271.
SLATER (J. E.). — The problem of mechanical
statistics. (4 200 words.)

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New equipment for Oriental Limited trains. (900 words
& fig.)

1924 621 .137.1 (.73) & 621 .138.2 (.73)
Railway Age, No. 26, May 31, p. 1327.
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1924 656 .222.1 (.73)
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BOSTWICK (A. L.). — Train speeds in America.
(1 300 words & table.)

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FORD (R. H.). — Can the grade crossing problem be
solved? (3 500 words.)

1924 621 .33 (.73)
Railway Age, No. 27, June 7, p. 1353.
SMITH (H. K.). — The Virginian Railway electrifi-
cation. (3 000 words & fig.)

1924 625 .123 (.73)
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Roads use corrugated culverts under fills. (4 700 words
& fig.)

1924 621 .138.5 (.73)
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How the Grand Rapids shops were modernized. (4 400
words & fig.)

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Railway Age, No. 31, June 14, p. 1507.
Gasoline passenger car with hydraulic driv. (1 800
words & fig.)

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Railway Age, No. 31, June 14, p. 1510.
PFLASTERER (G. S.). — Electric switch lighting in
yards on N. C. & St. L. (700 words & fig.)

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Mechanical draft. (2 400 words & fig.)

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Report on accounting distribution and statistics.
(2 000 words & fig.)

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Fluctuations in the number of railway clerks. (2 200
words, 7 tables & fig.)

1924 313 : 621.13 (.73) & 313 : 625 (.73)
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SLATER (J. E.). — The problem of mechanical
statistics. (2 500 words.)

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 A remarkable record in a turntable renewal. (1000 words & fig.)
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 Journal lubricating system. (700 words & fig.)
- 1924 725 .33 (.73)
 Railway Age, No. 38, June 28, p. 1807.
 Kansas City Southern enlarges its main shops. (3 400 words & fig.)

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- 1924 625 .232 (.68)
 Railway Engineer, July, p. 241.
 New carriages for the South African Railways. (900 words & fig.)
- 1924 621 .132.6 (.54)
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 New 2-8-2 type tank engines for the East Indian Railway. (350 words & fig.)

Railway Engineering and Maintenance. (Chicago.)

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 Railway Engineering and Maintenance, June, p. 222.
 CRAWFORD (D. K.). — Use spring switches to eliminate interlockers on Santa Fe. (700 words & fig.)
- 1924 625 .123 (.73)
 Railway Engineering and Maintenance, June, p. 224.
 LACHER (W. S.). — Is the corrugated iron culvert adapted to railroad use. (6 000 words & fig.)
- 1924 725 .33 (.73)
 Railway Engineering and Maintenance, June, p. 233.
 KNOWLES (C. R.). — New pumping and softening plant is electrical throughout. (3 300 words & fig.)
- 1924 625 .142.4 (.73)
 Railway Engineering and Maintenance, June, p. 239.
 Concrete ties on Pennsylvania show long service life. (400 words & fig.)
- 1924 725 .31 (.73)
 Railway Engineering and Maintenance, July, p. 261.
 A small union passenger station for Southern Railroads. (1 500 words & fig.)
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 Railway Engineering and Maintenance, July, p. 268.
 OLSON (E. H.). — Santa Fe builds new water stations where supply is limited. (3 500 words & fig.)

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 Railway Engineering and Maintenance, July, p. 279.
 How rail expansion actually occurs. (1 300 words & fig.)

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 The first « Garratt » locomotive in Great Britain (2 000 words & fig.)
- 1924 625 .616 (.5)
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 New 4-6-0 type metre gauge locomotives, Bombay Baroda & Central India Railway. (700 words & fig.)
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 WRENCH (A.). — Locomotive firebox staybol (1 500 words & fig.)
- 1924 625 .162 (.4)
 Railway Gazette & News, No. 25, June 20, p. 879.
 THORROWGOOD (W. J.). — Electrically operated gates at Mount Pleasant crossing, Southampton, Southern Railway. (1 600 words & fig.)
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 A new Pennsylvania R. R. locomotive. (850 words & fig.)
- 1924 621 .132.3 (.44) & 621 .132.6 (.4)
 Railway Gazette & News, No. 26, June 27, p. 923.
 New locomotives for French Railways. (900 words & fig.)
- 1924 625 .216 (.5)
 Railway Gazette & News, No. 26, June 27, p. 926.
 Automatic couplings in Japan. (600 words & fig.)
- 1924 625 .13 (.42 + .4)
 Railway Gazette & News, No. 26, June 27, p. 949.
 The Channel tunnel. (5 500 words.)
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 Railway Gazette & News, No. 1, July 4, p. 13.
 New locomotives for the Algerian State Railway (1 500 words & fig.)
- 1924 625 .13 (.42 + .4)
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 House of Commons Channel tunnel Committee. (5 000 words.)
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 Handling tranships at Crewe, L. M. S. (2 600 words & fig.)

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 ALLEN (C. J.). — British locomotive practice & performance. (4 900 words, 3 tables & fig.)

Railway Mechanical Engineer. (New York.)

- 1924 621 .9
Railway Mechanical Engineer, June, p. 325.
SHAFFER (C. A.). — Does it pay to install modern
shop machinery? (3 700 words, 2 tables & fig.)
- 1924 625 .27 (.73)
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HARRISON (W. H.). — Central of Georgia reclaims
metal car roofs. (1 300 words & fig.)
- 1924 621 .138.5 (.73)
Railway Mechanical Engineer, June, p. 333.
Improved shop operation at Albuquerque, N. M. (6 700
words, 1 table & fig.)
- 1924 621 .94 (.73)
Railway Mechanical Engineer, June, p. 345.
RICHARDSON (M. B.). — Grinding practice in rail-
road shops. (2 200 words, 1 table & fig.)
- 1924 385. (07.13 (.73)
Railway Mechanical Engineer, June, p. 355.
Apprenticeship methods on the Santa Fe. (2 600 words
& fig.)
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Railway Mechanical Engineer, June, p. 360.
GIBBONS (J. W.). — The possibilities of mechanical
painting. (900 words & fig.)
- 1924 621 .133.4 & 621 .133.5
Railway Mechanical Engineer, June, p. 362.
DERROM (D. L.). — Exhaust nozzle and front end
adjustment. (3 000 words & fig.)

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Box cars rebuilt in record time, D. & H. Co. (2 700
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- 1924 625 .251 (.73)
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STENASON (W. G.). — Freight car foundation brake
design. (1 100 words & fig.)
- 1924 621 .132.8 (.73) & 621 .43 (.73)
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Gasoline motorized passenger coach, Minnesota Da-
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New Santa Fe express refrigerator cars. (4 500 words
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Railway Review, No. 22, May 31, p. 958.
KNOWLES (C. R.). — Water station and softening
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AISHTON (R. H.). — Some aspects of the problem
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Railway Review, No. 23, June 7, p. 989.
A constructive study of railroad car repairs. (6 800
words & fig.)
- 1924 621 .133.2 & 621 .133.4
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SCHMIDT (E. C.). — Report on front-ends, grates
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(10 000 words & fig.)
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WURTS (T. C.). — New electric locomotives of the
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- 1924 621 .135.2
Railway Review, No. 23, June 7, p. 1029.
Machining driving boxes, shoes and wedges. (7 000
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- 1924 621 .7 (.73) & 625 .26 (.73)
Railway Review, No. 23, June 7, p. 1040.
RICHARDSON (G. A.). — Improvements in the
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- 1924 625 .211 (.73) & 625 .213 (.73)
Railway Review, No. 23, June 7, p. 1051.
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car truck. (3 700 words & fig.)
- 1924 621 .132.5 (.73)
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Performance of 3-cylinder locomotive, No. 5000.
(8 500 words, tables & fig.)
- 1924 625 .27 (.73) & 725 .35 (.73)
Railway Review, No. 24, June 14, p. 1094.
S. P. Houston store has many fine features. (3 800
words & fig.)
- 1924 621 .131 (.73)
Railway Review, No. 24, June 14, p. 1103.
WINTERROWD (W. H.). — Engineering and
business considerations of the locomotive. (4 400 words
& fig.)
- 1924 621 .138.5 (.73) & 625 .26 (.73)
Railway Review, No. 24, June 14, p. 1108.
Pere Marquette Ry. enlarges its Wyoming shops.
(8 500 words & fig.)
- 1924 621 .334 (.73)
Railway Review, No. 24, June 14, p. 1126.
THOMAS (J. M.). — Transportation of material in
the Roanoke shops. (3 200 words & fig.)
- 1924 625 .23 (09.3 (.73)
Railway Review, No. 24, June 14, p. 1133.
RICHARDSON (G. A.). — History and development
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1924 621 .7 (.73)
 Railway Review, No. 25, June 21, p. 1177.
 Car building program in a railroad shop. (4 100 words & fig.)

1924 625 .2 (01 (.73)
 Railway Review, No. 25, June 21, p. 1186.
 Report of Committee on car construction. (3 000 words & fig.)

1924 621 .335 (.73)
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 EUNSON (W. H.). — Pennsylvania R. R. 2-8-2 type electric locomotive. (1 800 words & fig.)

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 Railway Review, No. 25, June 21, p. 1192.
 Operating problems under electric motive power. (3 500 words & fig.)

1924 621 .13 (06)
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 Fifth annual meeting of the mechanical division. (9 000 words & fig.)

Railway Signaling. (Chicago.)

1924 656 .253 (.73) & 656 .256.3 (.73)
 Railway Signaling, June, p. 230.
 Single track signaling on C. B. & Q. (2 000 words & fig.)

1924 656 .256.3 (.73)
 Railway Signaling, June, p. 242.
 STAHL (L. R.). — Engineering and installation of automatic block signals. (2 000 words.)

1924 625 .151 (.73)
 Railway Signaling, June, p. 244.
 CRAWFORD (D. K.). — Use spring switches to eliminate interlockers on Santa Fe. (800 words & fig.)

1924 656 .253 (.73)
 Railway Signaling, June, p. 247.
 New design of Brookins train control. (1 600 words & fig.)

1924 656 .254 (.73)
 Railway Signaling, June, p. 253.
 CAPEN (W. H.). — Recent developments in telephone train dispatching circuits. (2 800 words & fig.)

University of Illinois Bulletin. (Urbana.)

1924 62. (01 & 669 .1)
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 MOORE (H. F.) & JASPER (T. M.). — An investigation of the fatigue of metals. (14 000 words, 14 tables & fig.)

In Italian.

Rivista tecnica delle ferrovie italiane. (Roma)

1924 621 .43 (.45) & 621 .335 (.4)
 Rivista tecnica delle ferrovie, 15 maggio, p. 145.
 SONA (G.). — Una locomotiva italiana Diesel-eltrica. (3 400 parole & fig.)

1924 625 .4 (.45) & 656 .211.5 (.4)
 Rivista tecnica delle ferrovie, 15 maggio, p. 159.
 Scale mobili per il tratto urbano in Napoli de linea direttissima Roma-Napoli. (4 000 parole, 2 quadri & fig.)

Rivista dei trasporti. (Milano.)

1924 621 .335 (.45) & 621 .43 (.4)
 Rivista dei trasporti, giugno, p. 87.
 MELLINI (E.). — Locomotori petroleo-elettrici Diesel-ellettrici per ferrovie e tranvie. (7 500 parole & fig.)

1924 621 .3
 Rivista dei trasporti, giugno, p. 94.
 GATTANEO (M.). — Esperienze su prese di corrente a pantografo. (900 parole & fig.)

In Spanish.

Revista de Obras Públicas. (Madrid.)

1924 624 .63 (.46)
 Revista de Obras Públicas, No. 11, 1 de junio, p. 202.
 Viaducto de San Juan de las Abadesas, de hormigón armado, con articulaciones Mesnager. (1 200 palabras & fig.)

1924 721
 Revista de Obras Públicas, No. 11, 1 de junio, p. 205.
 LOPEZ RODRIGUEZ (J.). — En torno a un ejercicio de Zafra. (3 200 palabras, 3 cuadros & fig.)

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 Revista de Obras Públicas, No. 11, 1 de junio, p. 215.
 Consejo superior de ferrocarriles. Proyecto de bases para un nuevo régimen ferroviario. (3 000 palabras.)

In Dutch.

Locomotief. (Rotterdam.)

1924 625 .232 (.492)
 De Locomotief, n° 27, 2 Juli, p. 209.
 Stalen rijtuigen voor de Nederlandsche Spoorwegen (350 woorden & fig.)

MONTHLY BIBLIOGRAPHY OF RAILWAYS⁽¹⁾

PUBLISHED UNDER THE SUPERVISION OF

J. VERDEYEN,

General secretary of the Permanent Commission of the International Railway Congress Association.

[016 .385. (02)]

I. — BOOKS.

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|---|-----------------|--|----------------|
| In French. | | 1924 | 669 .1 (02) |
| 1924 | 625 .144.3 (02) | BRICHEROUX (F.), ingénieur A. I. Lg. | |
| LLEGRET, ingénieur principal, & IMBERT, ingénieur aux Chemins de fer de l'Etat français. | | Principes de sidérurgie. | |
| Raccordements paraboliques des courbes circulaires avec les alignements (Cours de chemins de fer). | | Paris-Liège, Ch. Béranger. (165 × 250), 505 pages & fig. | |
| 1924 | 385. (02 .44) | 1924 | 351. (02) |
| Annuaire des chemins de fer et des tramways (ancien Marchal), 1924, 35 ^e année. | | CAPART (Maurice), directeur au Ministère de l'industrie et du travail, professeur à l'Institut technique du commerce et de la finance. | |
| Paris (VIII ^e), 33, boulevard Malesherbes. 1 vol. in-8°, 027 pages, fig. & plans. (Prix : 25 francs.) | | Droit administratif élémentaire. Préface de M. Louis Wodon, secrétaire général du Ministère des affaires économiques, professeur à l'Université de Bruxelles. | |
| 1924 | 385. (02) | Bruxelles, V ^{ve} Ferdinand Larcier; 2 ^e édition. (160 × 245), de xxvii-476 pages. (Prix : 30 francs.) | |
| Annuaire général de la France et de l'étranger. 1924, 35 ^e année. | | 1924 | 621 .392. (02) |
| Paris, Librairie Larousse, 13-17, rue Montparnasse. n-8° de xxiii-1 107 pages, 25 cartes, graphiques et diagrammes. (Prix : 45 francs.) | | CHAMBRE SYNDICALE DE L'ACÉTYLÈNE, DE LA SOUDURE AUTOGENE ET DES INDUSTRIES QUI S'Y RATTACHENT. | |
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| 1924 | 721. (02) | 1923-1924 | 625 .6 (02) |
| BARBEROT (E.), architecte, membre de la Société centrale des architectes. | | Chemins de fer d'intérêt local, tramways, services publics automobiles. | |
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| BAUDART (Charles), ingénieur des arts et manufactures, ingénieur en chef des services municipaux de la ville de Bangkok. | | Ordre général n° 20 relatif à l'instruction et au règlement des réclamations et litiges. Edition de 1921. | |
| Béton armé. Tables de calcul des dalles et poutres. | | Paris, impr. et libr. Chaix, 20, rue Bergère. In-8°, 192 pages. | |
| Paris (V ^e), Librairie de l'enseignement technique, Léon Eyrolles, éditeur, 3, rue Thénard. Un volume de 118 pages dont 75 de tableaux. (Prix : fr. 10.70.) | | 1924 | 33. (02) |
| 1924 | 721 .9 (02) | COLSON (C.), inspecteur général des ponts et chaussées, président de section au Conseil d'Etat, membre de l'Académie des sciences morales et politiques. | |
| BOLL (G.), ingénieur des arts et métiers. | | Cours d'économie politique professé à l'Ecole polytechnique et à l'Ecole nationale des ponts et chaussées. Livre premier : Théorie générale des phénomènes économiques. | |
| Constructions métalliques. Bâtiment et travaux publics. Album de profils employés dans les constructions métalliques et renseignements pour l'étude des avant-projets. | | Paris, impr.-libr.-éditeurs Gauthier-Villars et C ^{ie} , 55, quai des Grands-Augustins; Félix Alcan, éditeur, 108, boulevard Saint-Germain. Edition définitive. In-8°, 559 pages & fig. | |
| Paris (V ^e), Librairie de l'enseignement technique, Léon Eyrolles, éditeur, 3, rue Thénard. (170 × 220), 117 pages. (Prix : 15 francs.) | | | |

(¹) The numbers placed over the title of each book are those of the decimal classification proposed by the Railway Congress conjointly with the Office Bibliographique International, of Brussels. (See "Bibliographical Decimal Classification as applied to Railway Science", by L. WEISSBRUCH, in the number for November, 1897, of the *Bulletin of the International Railway Congress*, p. 1509.)

1924 721. (02)
DARDART (E.) & BONNAL (A.).

Devis et évaluations. 2^e édition, revue et complétée par A. Bonnal. A l'usage des ingénieurs des travaux publics, des architectes et des entrepreneurs.

Paris (VI^e), Dunod, 92, rue Bonaparte. (140 × 225), x-803 pages. (Prix : 48 francs.)

1923 385. (02)

DAUTRY, ancien élève de l'Ecole polytechnique, ingénieur en chef à la Compagnie du Nord; GERVET, ingénieur des ponts et chaussées, ingénieur principal aux Chemins de fer de l'Etat; & MASSE, inspecteur divisionnaire des services techniques de la voie à la Compagnie d'Orléans.

Cours de chemins de fer. 5^e partie : Exploitation technique.

Vannes, impr. Lafolye frères; Paris, Ecole spéciale des travaux publics, rue du Sommerard, rue Thénard et boulevard Saint-Germain. In-8°, 160 pages & fig.

1924 531. (02)

DESARCES (Henri), ingénieur des arts et manufactures.

Cours de mécanique théorique et appliquée. Cours élémentaire.

Paris (VI^e), librairie Octave Doin, Gaston Doin, éditeur, 8, place de l'Odéon. In-16 de 420 pages avec 200 fig. (Prix : 15 francs.)

1924 621 .39 (02)

FRIMAUDEAU (S.), ingénieur E. S. E.

La soudure électrique à l'arc métallique.

Paris (VI^e), Gauthier-Villars et C^{ie}, imprimeurs-éditeurs, 55, quai des Grands-Augustins. In-8° (135 × 190), vi-136 pages avec 80 fig. (Prix : 10 francs.)

1924 621 .31 (02)

GILLON (G.), professeur à l'Université catholique de Louvain.

Dynamos et moteurs. Album de plans et croquis de machines électriques.

Paris (VI^e), Dunod, éditeur, 92, rue Bonaparte. (280 × 400), 27 planches. (Prix : 36 francs.)

1924 621 .31 (02)

GILLON (G.), professeur à l'Université catholique de Louvain.

Dynamos et moteurs électriques. Tome I : Dynamos. Cours électrotechnique professé à l'Institut électromécanique de l'Université de Louvain.

Paris (VI^e), Dunod, éditeur, 92, rue Bonaparte. (160 × 250) de 506 pages avec 627 fig. (Prix : 80 fr.)

1924 669. (02)

JACQUET (A.), ex-professeur de l'enseignement technique, & TOMBECK (D.), docteur ès sciences.

Eléments de métallurgie. Deuxième édition de : Eléments de marchandises, tome II.

Paris (VI^e), Dunod, éditeur, 92, rue Bonaparte. (130 × 210), vin-270 pages avec 240 fig. (Prix : 12 fr.)

1924 621 .1 (0)

JOLLY (E.), ingénieur des arts et manufactures, professeur à l'Ecole Bréguet.

Cours pratique de machine à vapeur.

Paris. « Revue de l'Ingénieur », rue de Ponthieu, 53 (130 × 210), iv-384 pages avec 350 fig. (Prix : 32 fr.)

1924 62. (02)

LAHARPE (de).

Notes et formules de l'ingénieur.

Paris, Albin Michel, éditeur. 21^e édition. 2 volumes. (Prix : 95 francs.)

1924 656 .23 (02)

LAMY (L.), fondateur du « Bulletin des transports ».

Manuel pratique des transports par chemins de fer.

Paris, édité par la « Ligue de défense contre les chemins de fer », 155bis, rue Legendre. 10^e édition. In-8°. 509 pages. (Prix : 25 francs.)

1924 385 .114. (01)

LEROY (Thérèse), diplômée d'études supérieures de mathématiques.

Essais de détermination du prix de revient des transports par chemins de fer. Esquisse d'une tarification résultant de la connaissance du prix de revient.

Montrouge (Seine), Imprimerie de l'édition et de l'industrie. In-8°. (160 × 240), de 48 pages & 6 planches.

1924 385 .114. (01)

LEROY (Thérèse), diplômée d'études supérieures de mathématiques.

La rotation du matériel dans les chemins de fer considérée au point de vue de la détermination du prix de revient des opérations qu'elle comporte.

Paris (IX^e). Bureau d'études de M. Gustave Péreire, 69, rue de la Victoire. In-8°. (160 × 240), de 54 pages & fig.

1924 385. (09.1) (.44)

MARCHAND (A.), inspecteur général à la Compagnie des Chemins de fer de l'Est.

Les chemins de fer de l'Est et la guerre de 1914-1918.

Paris (VI^e), 136, boulevard Saint-Germain; Nancy et Strasbourg. Librairie Berger-Levrault. In-8° (165 × 255) de 612 pages. (Prix : 40 francs net.)

1924 69 (02)

NACHTERGAL (A.), ingénieur, professeur à l'Ecole des arts et métiers d'Etterbeek.

Agenda du bâtiment à l'usage des ingénieurs, architectes, dessinateurs, entrepreneurs, commissaires-voyers, géomètres, conducteurs de travaux et de tous les corps de métiers se rattachant à la construction du bâtiment.

Bruxelles, A. De Boeck, 10^e édition. (100 × 150), 420 pages & 300 fig. (Prix : 10 francs.)

1924 621 .14 (02)

PREVOST (Pierre), capitaine d'artillerie, ancien élève de l'Ecole polytechnique.

Organisation et fonctionnement des véhicules automobiles. Cours professé au Centre d'instruction automobile de Fontainebleau.

Paris, « Revue de l'Ingénieur », rue de Ponthieu, 53. (160 × 250), de 792 pages avec 653 fig. (Prix : 48 fr.)

1924 691. (02)
RABOZÉE (H.), professeur, directeur du laboratoire
 d'essai des matériaux de l'Ecole militaire.

Cours de connaissance des matériaux. Tome I. Les
 métaux et les bois.

Bruxelles, impr. Stevens frères (Ramlot frères et
 sœurs). Paris, Dumod. (170 × 250), 293 pages & fig.
 (Prix : fr. 37.50.)

1921 625 .13 (02)
ROUSSELET (Louis), & PETIT (Aimé), ingénieurs
 A. et M.

Stabilité des infrastructures et ouvrages d'art en
 maçonnerie. Tome premier : Généralités. Recherches
 théoriques. Appendice.

Paris (VI*), 15, rue des Saints-Pères; Liège, rue des
 Dominicains, 8, Librairie polytechnique Ch. Béranger.
 In-4° (200 × 260) de 404 pages avec 219 fig. (Prix net :
 55 francs.)

1924 621 .3 (02)
STRUVOVICI (M.), ingénieur-électricien.

Manuel de l'électricien : moteurs électriques, traction
 électrique.

Paris (VI*), J.-B. Baillière et fils, éditeurs, 19, rue
 Hautefeuille. (110 × 160), 576 pages avec 200 fig. (Prix :
 18 francs.)

1924 669. (02)
WILLEM (Jules), ingénieur civil des mines (A. I. Lg.),
 chef de service à la Société Cockerill.

Traité élémentaire de métallurgie et de technologie
 métallurgique.

Paris (VI*), 15, rue des Saints-Pères; Liège, rue des
 Dominicains, 8, Librairie polytechnique Ch. Béranger.
 In-8° (135 × 210) de 430 pages avec fig. (Prix net :
 27 francs.)

In German.

1924 621 .14 (02)
BARSCH (Otto), Oberingenieur.

Der Autotriebwagen, sein Bau und Betrieb.

Berlin W. 62, Verlagsbuchhandlung Richard Carl
 Schmidt & Co. 196 Seiten mit 83 Abb. im Texte. (Preis :
 3.50 G.-M.)

1924 624. (02)
BLEICH (Friedrich), Dr.-Ing.

Theorie und Berechnung der Eisernen Brücken.

Berlin, Julius Springer. (Preis : \$9.)

1924 621 .43 (01 & 621 .335. (01)
BROWN (Dr.-Ing. Herbert), z. Z. in der Firma Brown,
 Boveri & Co.

Ueber Diesel-elektrische Lokomotiven im Vollbahn-
 betrieb. Theorie, Betriebsverhältnisse und Wirtschaft-
 lichkeit.

Zürich, Ernst Waldmann. 68 Seiten u. 27 Abb.

1924 669. (02)
CZOCHRALSKI (J.).

Moderne Metallkunde im Theorie und Praxis.

Berlin, Julius Springer. (Preis : \$2.85.)

1924 721 .9 (02)
FOERSTER (Max), Dr.-Ing. e. h.

Die Eisenkonstruktionen der Ingenieur-Hochbauten.
 Ein Lehrbuch zum Gebrauche an technischen Hochschulen
 und in der Praxis.

Leipzig, Verlag Wilhelm Engelmann. 1320 Seiten u.
 1332 Abb. (Preis : 45 Mark.)

1924 62. (01 & 721. (01)
GRAF (Otto).

Versuche ueber die Druckelastizität und Druckfestig-
 keit von Mauerwerk namentlich zur Ermittlung des
 Einflusses verschiedener Mortel auf die Druckelastizität
 von Beton- und Backsteinmauerwerk.

Berlin, W. Ernst & Sohn. In-8°, 40 Seiten. (Preis :
 2.10 Schweizer Franken.)

1924 621 .1 (02)
GRASSMANN, Professor an der Technischen Hoch-
 schule in Karlsruhe.

Anleitung zur Berechnung einer Dampfmaschine.

Berlin, W. 9, Verlag von Julius Springer. Vierte
 Auflage. (160 × 230), 643 Seiten mit 471 Abb. (Preis
 geb. : \$6.70.)

1924 625 .13 (02)
LUCAS (G.), Professor.

Der Tunnel. Anlage und Bau. 2. Band.

Berlin, Verlag von Wilhelm Ernst. 169 Seiten u.
 238 Abb. (Preis : 14.28 Schweizer Franken.)

1923 721. (02)
PIRLET (J.), Dr.-Ing., Privatdozent a. d. T. H. Aachen.

Kompodium der Statik der Baukonstruktionen.
 Zweiter Band : Die statisch unbestimmten Systeme.
 Zweiter Teil : Berechnung der einfacheren statisch un-
 bestimmten Systeme : Gerade Balken mit Endenspan-
 nungen und mehr als zwei Stützen; Einfache Rahmen-
 gebilde; Zweigelenkbogen; Gewölbe; Armierter Balken.

Berlin, Julius Springer. 314 Seiten mit 298 Text-
 figuren.

1924 721 .9 (02)
STAHLWERKS-VERBAND A.-G., Abteilung technisches
 Büro, Düsseldorf.

Eisen im Hochbau. Ein Taschenbuch mit Zeichnun-
 gen, Zusammenstellungen, technischen Vorschriften und
 Angaben über die Verwendung von Eisen im Hochbau.

Berlin, Julius Springer. Sechste umgearbeitete und
 erweiterte Auflage. (Preis geb. : 12 G.-M.)

1924 385. (02)
 Taschenbuch für alle Angehörigen der Werkstätten
 der Deutschen Reichsbahn auf das Jahr 1924. Heraus-
 gegeben unter Benutzung amtlichen Materials und
 unter Mitwirkung von Fachleuten.

Berlin W. 57, Verlag technischer Zeitschriften H.
 Apitz (Preis : 1.20 G.-M.)

1924 621 .33 (.43)
WECHMANN (Wilhelm).

Der elektrische Zugbetrieb der Deutschen Reichsbahn.

Berlin, R. Otto Mittelbach, Charlottenburg, 5. 402
 Seiten.

1924 625 .1 (02)
WEITBRECHT (M.), Baurat, Professor, Dozent für geodätische Fächer an der Technischen Hochschule Stuttgart; u. **KNOBLICH (M.)**, Oberlandmesser, Rechnungsrat bei der Reichsbahndirektion Stuttgart.
Knoll's Taschenbuch zum Abstecken der Kurven an Strassen und Eisenbahnen.
 Leipzig, Verlag von Alfred Kröner. Mit 75 Abbildungen u. 10 Zahlentafeln.

1924 625 .1 (02)
WILLMANN (L. von).
Handbuch der Ingenieurwissenschaften in fünf Teilen. Erster Teil: Vorarbeiten und Bauausführung, Erd-, Grund-, Strassen- und Tunnelbau. Erster Band. Erstes Kapitel. Vorarbeiten für Eisenbahnen und Strassen.
 Leipzig, Verlag von Wilhelm Engelmann. Fünfte Auflage.

In English.

1924 313:656 .28 (.42)
Accidents. Reports of Inspecting Officers on inquiries into accidents during July-September, 1923.

London, P. S. King & Son, Limited. Publishers, Parliamentary and General Booksellers, Orchard House, 2 and 4, Great Smith Street, Westminster. (Price : 4 s. 6 d.)

1924 625 .253. (02)
AMERICAN RAILWAY ASSOCIATION.
Maintenance of brake and train air signal equipment.
 New York, 30, Vesey Street; Chicago, 431, South Dearborn Street, published by the Association. 38 pages, tables & fig.

1924 624. (06 (.73)
AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION.
Proceedings of the thirty-seventh annual convention held at Seattle, Wash., on October 16-18, 1923.
 Chicago, published by the Association, C. A. Lichty, secretary, Chicago & North Western Railway. (6 × 9 inches), 256 pages, illust.

1924 621. (02)
AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
The Engineering Index-1923.
 New York, published by the Association. (6 1/2 × 9 1/2 inches), 700 pages.

1924 625 .142.2 (06 (.73) & 691. (06 (.73)
AMERICAN WOOD PRESERVER'S ASSOCIATION.
Proceedings of the twentieth annual meeting held at Kansas City, Mo., in January 1924.
 Chicago, published by the Association, 1146, Otis Building. P. R. Hicks, secretary. (6 × 9 inches), 375 pages.

1924 621 .131.3 (.73)
CANTLEY (W. I.).
Official test of three cylinder locomotive number 5 000 of the Lehigh Valley Railroad. 8^{re}, 26 pages.

1921 653. (02)
DONOVAN (Edwin), formerly chief clerk to the chief engineer of the International & Great Northern Railway.

Railway stenographer's handbook.
 New York, published by Simmons-Boardman Publishing Company. (5 × 7 inches), 178 pages. (Price : \$2.00.)

1924 621 .116. (02)
DROVER (F. J.), engineer-commander, R. N.
Coal and oil-fired boilers.
 London, W. C. 2. Chapman & Hall, 11, Henrietta Street, Covent Garden. (Price : 16 s. net.)

1924 313 .385 (.59) & 385. (08 (.59)
FEDERATED MALAY STATES RAILWAYS.
Report for the year 1923.
 Kuala Lumpur, printed at the Federated Malay States Government Printing Office. In-4°, 41 pages illustr. with a map.

1914 313 .385 (.66) & 385. (08 (.66)
GOLD COAST RAILWAY.
Administration report for the year 1923-24.
 Secondee Gold Coast, Railway Press. In-4°, 63 pages. 12 tables & fig.

1924 385. (09.1 (.73)
Great Northern Railway Company. Northern Pacific Railway Company. A review of their operations in the period 1916-1923, and a discussion of some of their most difficult problems. Includes comment on current conditions by the presidents of these roads.
 New York, published by Wood Struthers. 131 pages. map.

1924 625 .2 (02)
HARTOUGH (E. W.), formerly general car foreman on Missouri, Kansas and Texas and Pere Marquette.
Car inspector's handbook.
 New York, published by the Simmons-Boardman Publishing Company. 30 Church Street. (4 1/2 × 7 inches), 284 pages. (Price : \$2.50.)

1924 385. (09.3 (.54)
History of Indian Railways, 1918-1923. Second quinquennial.
 Simla, Government Central Press. (13 × 8 1/4 inches). (Price : 8 s. 9 d.)

1924 621 .39 (02)
HOLSLAG (C. J.), chief engineer.
Arc welding handbook.
 New York, McGraw-Hill Book Company. (Price : \$2.00.)

1924 691. (02 & 693. (02)
HOOL (A.), C. E., & KINNE (W. S.), professors of structural engineering, University of Wisconsin.
Reinforced concrete and masonry structures.
 New York and London, McGraw-Hill Book Company. Inc. (6 × 9 inches), 786 pages. (Price : \$6.00.)

1924 721 .9 (02)
HUSBAND (Joseph), M. Am. Soc. C. E., & HARBY
 (William).
Structural engineering.
 London, Longmans, Green & Co. Third edition.
 (5 1/2 X 8 1/2 inches), 458 pages. (Price : 16 s.)

1924 385 .15 (.42 + .431 + .54)
JAGTIANI (H. M.), M. Sc.
The role of the State in the provision of railways.
 With an introduction by Sir William Acworth, K. C.
 S. I.
 London, P. S. King & Son, Limited. Publishers. Par-
 liamentary and General Booksellers, Orchard House,
 2 & 4, Great Smith Street, Westminster. Demy 8vo.
 156 pages. (Price : 8 s. 6 d.)

1924 385. (09.1 (.73)
JONES (Eliot).
Principles of railway transportation. Includes maps
 showing development of railroads by periods, and
 selected reading lists.
 New York, published by MacMillan. 607 pages.
 (Price : \$3.50.)

1924 62. (03)
KETTRIDGE (J. O.).
French-English and English-French dictionary of
technical and general terms, phrases and abbreviations.
 London, George Routledge & Sons, Limited, Broad-
 way House, 68-74, Carter-lane, E. C. 4. (Price : 10 s. 6 d.
 net.)

1924 621. (02)
LOW (D. A.), Wh. Sc., M. I. Mech. E.
Applied mechanics.
 London, E. C. 4, Longmans, Green & Co., 39, Pater-
 noster Row. 551 pages & 850 ff. 780 exercises. (Price :
 12 s. 6 d. net.)

1922 621 .1 (02)
LOW (D. A.), Wh. Sc., M. I. Mech. E.
Heat engines.
 London, E. C. 4, Longmans, Green & Co., 39, Pater-
 noster Row. (5 3/4 X 8 3/4 X 1 5/8 inches). 592 pages
 & 656 ff. 315 exercises. (Price : 15 s. net.)

1924 621 .39 (03)
MACKENZIE (L. B.) & CARD (H. S.).
Welding encyclopedia.
 Chicago, Welding Engineer Publishing Co., Fourth
 edition. (6 X 9 inches), 435 pages, illust. (Price : \$5.00.)

1924 625 .253. (02)
McSHANE (Chas. L.).
Modern air brakes.
 Chicago, Ill., published by Griffin & Winters, New
 York Life Bldg. (4 3/4 X 7 1/2 inches), 532 pages.
 (Price : \$4.00.)

1924 62. (02)
MANN (E. E.), M. Sc.
An introduction to the practice of civil engineering.
 London : MacMillan & Co., Limited. (Price : 7 s. 6 d.
 net.)

1924 313:656 .28 (.42)
MINISTRY OF TRANSPORT, GREAT BRITAIN.
Railway accidents. Report issued by Ministry of
 Transport, Great Britain, of accidents during the three
 months ended December 31, 1923.
 London, published by His Majesty's Stationery
 Office. 62 pages. (Price : 5 s.)

1924 313 .385 (.66) & 385. (08 (.66)
NIGERIAN RAILWAY AND UDI COAL MINES.
Administrative report for the year ending 31st March.
 1924.
 Ebute Metta, printed by the Superintendent of press.
 89 pages illust., with appendices and a map.

1924 621 .33 (.73)
NORRIS (Henry H.).
Electric railway practices in 1923.
 New York, N. Y., published by the American Electric
 Railway Association. (Price : \$2.00.)

1924 614 .8 (.73) & 656 .286 (.73)
Proceedings of the National Conference on preven-
tion of railroad-highway crossing accidents under the
auspices of the National Association of Railroad &
Public Utilities Commissioners. April 30-May 1, 1924.
 New York City, available from American Railway
 Association. 140 pages. (Price : \$1.85.)

1924 625 .22 (.54)
RICHARDS (G.) & WHITE (J. H.), C. M. G., chief
engineers with the Railway Board.
Notes on the « Standard dimensions » of Indian rail-
ways.

Calcutta, India. Superintendent, Government Print-
 ing, 8, Hastings street. Technical paper No. 236.
 (8 3/8 X 13 1/8 inches), 106 pages & 10 folding plates.
 (Price : Rs. 2 As. 12.)

1924 621 .33 (02)
RICHEY (Albert S.), consulting engineer, professor of
electric railway engineering, Worcester Polytechnic
Institute.

Electric railway handbook.
 New York, McGraw-Hill Book Co. Inc., 370, Seventh
 Avenue, 800 pages, 600 illust. (Price : \$4.00 net.)

1924 62. (03)
ROGET (S. R.), M. A. (Cantab.) Assoc. M. Inst. C. E.,
A. M. I. E. E.

A dictionary of electrical terms.
 London, W. C. 2., Sir Isaac Pitman & Sons, Limited.
 Parker-Street, Kingsway. (Price : 7 s. 6 d. net.)

1924 621 .31 (02 & 627. (02)
RUSHMORE (David B.) & LOF (Eric A.).
Hydro-electric power stations.
 New York, John Wiley & Sons, Inc. (6 X 9 inches),
 830 pages. (Price : \$7.50.)

1924 385. (02)
The Universal Directory of Railway Officials, 1924.
 London, S. W. 1. The Directory Publishing Co.,
 Limited, 33, Tothill Street. 8 5/8 X 5 1/2 X 3/4 inches),
 415 pages. (Price : 20 s.)

1923 313 .385 (.73)
Thirty-fifth annual report on the statistics of rail-
ways in the United States for the year ended December
31, 1921. Together with abstracts of periodical reports
for the year ended December 31, 1922.
Washington.

1924 721 .3 (01)
TURNER (C. A. P.).

Elasticity and strength of materials used in Engineer-
ing construction; Section IV : Columns.

Minneapolis, Minn. Published by the Author. (9 × 6
inches), 134 pages, illust. (Price : \$5.00.)

1924 62. (01 & 624. (02)
TURNER (C. A. P., consulting engineer.

Elasticity and strength of materials used in engineer-
ing construction. Section V : Economic theory of steel
railroad bridge design.

Minneapolis, Minn. Published by the Author. (6 × 9
inches), 129 pages. (Price : \$5.00.)

1924 385. (09.1 (.68)
UNION OF SOUTH AFRICA.

Railways and harbours. Compiled and issued under
the authority of the general manager.

Johannesburg. Publicity Department, South African
Railways and Harbours. 8°, 158 pages, illust.

1924 625 .214 (.73)
UNITED STATES FEDERAL SPECIFICATIONS
BOARD.

United States government specifications for lubri-
cants and liquid fuels and methods for testing.

Washington, D. C., published by Government Print-
ing Office. 89 pages and diag.

1924 313 .385 (.73)
UNITED STATES INTERSTATE COMMERCE COM-
MISSION.

Text of the thirty-sixth annual report on the statis-
tics of railways in the United States for the year ended
December 31, 1922.

Washington, D. C., published by Government Print-
ing Office. (Price : 20 cents.)

1924 385. (09.3 (.6)
WEINTHAL (Leo).

The story of the Cape to Cairo Railway and River
route, from 1887 to 1922.

London, published by Pioneer Publishing Company,
Ltd., 4 volumes. (Price : £10.10.0.)

In Italian.

1924 625 .1 (.45)
GAVIRAGHI (Carlo), ing.
Le linee ferroviarie e la galleria della Stelvio.
Tirano, 83 pagine.

In Spanish.

1923 62. (02)
GARUFFA (Egidio).
Formulario del ingeniero.
Barcelona, Gustavo Gili, editor, 644 páginas, con
975 figuras. (Precio : 17 pesetas.)

1924 313 .385 (.81) & 385. (08 (.81)
MINISTERIO DA VIAÇÃO E OBRAS PUBLICAS.
(Inspectoria federal das estradas.)
Estatística das estradas de ferro da união e das
fiscalizadas pela união relativa ao anno de 1919.
Rio de Janeiro, Imprensa Nacional. In-4°, 300 paginas.

1923 313 .385 (.81) & 385. (08 (.81)
PALHANO DE JESUS (Dr. José), inspector federal das
Estradas.
Relatorio apresentado ao Exmo. Sr. Ministro da
Viação e Obras Publicas. Anno de 1921.
Rio de Janeiro, impr. Nacional. Gr. in-8° (165 × 245).
268 paginas.

In Dutch.

1924 691. (02)
VAN DER KLOES (J.-A.), prof., met medewerking van
de ingenieurs E. Jacobs, M. E. H., Tjaden en
Dr. L. R. Wentholt.
Onze bouwmaterialen. Deel III. Mortels en beton.
Amsterdam, L.-J. Veen.

1924 347. (02)
VEREENIGING VAN DELFTSCHE INGENIEURS.
De rechtskennis van den ingenieur. Eerste deel :
Publiek recht, door Mr. Dr. K.-H. Bryen, Mr. J.-W.
Beyen, Mr. K.-H. Corporaal, Mr. Th.-P.-J. Masthoff en
Mr. J. Kunst.
Amsterdam, L.-J. Veen.

II. — PERIODICALS.

In French.

Annales des ponts et chaussées. (Paris.)

- 1924 625 .616 (.44)
Ann. des ponts et chauss., part. techn., juill.-août, p. 168.
REZEAU. — Automotrice actionnée à l'essence ou au gaz pauvre. (2 900 mots & fig.)

Annales des travaux publics de Belgique. (Bruxelles.)

- 1924 624 .2 (01)
Ann. des trav. publ. de Belgique, août, p. 581.
BAZANT (Z.). — Calcul des poutres continues sollicitées par un système de charges mobiles. (6 500 mots & fig.)

Arts et Métiers. (Paris.)

- 1924 621 .87. (01)
Arts et Métiers, juin, p. 220.
CATELLA (G.). — Note sur l'étude des appareils de levage. Grues de déchargement à moteurs électriques. (2 600 mots & fig.)

- 1924 624 .92. (01)
Arts et Métiers, juin, p. 227.
BUSSOD (A.). — Utilisation du calcul dans le tracage en charpente métallique. (2 700 mots, 4 tableaux & fig.)

- 1924 721 .4 (01)
Arts et Métiers, juin, p. 237.
COMBEL (G.). — Note sur le calcul des arcs surbaissés de section constante. (700 mots & fig.)

- 1924 624. (01)
Arts et Métiers, juillet, p. 276.
Calcul des pièces de pont. (900 mots & fig.)

Bulletin de la Société des ingénieurs civils de France. (Paris.)

- 1924 621 .392
Bull. de la Soc. des ing. civ. de France, janv.-mars, p. 182.
THOMAS (R.). — L'état actuel de la soudure autogène et du découpage des métaux. (8 200 mots & fig.)

- 1924 625 .612
Bull. de la Soc. des ing. civ. de France, avril-juin, p. 355.
GRUET. — Ce que l'on peut faire sur une voie métrique. (2 800 mots & fig.)

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- 1924 621 .31 (.44)
Bull. techn. de la Suisse romande, 19 juillet, p. 185.
Note sur l'usine de Chancy-Pougny. (2 200 mots & fig.)

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- Bull. techn. de la Suisse romande, n° 19, 13 sept., p. 242.
Appareils pour fondre la neige. (1 400 mots & fig.)

Chronique des transports. (Paris.)

- 1924 385 .589 (.44)
Chronique des transports, n° 14, 25 juillet, p. 2.
La réintégration des révoqués. (3 000 mots.)

Génie civil. (Paris.)

- 1924 621 .39 & 625 .234
Génie civil, n° 2188, 19 juillet, p. 72.
Le réglage thermostatique de la température sur les voitures chauffées électriquement. (800 mots & fig.)

- 1924 621 .132.8 (.485)
Génie civil, n° 2188, 19 juillet, p. 74.
Les essais en service régulier de la locomotive à turbine à vapeur, système Ljungström. (300 mots & fig.)

- 1924 62. (01 & 721 .9
Génie civil, n° 2189, 26 juillet, p. 89.
CHAUDY (F.). — Planchers à poutrelles en acier ou en bois avec hourdis en béton armé. (2 600 mots & fig.)

- 1924 621 .95
Génie civil, n° 2189, 26 juillet, p. 91.
SAVINE (N.). — Les meilleures conditions du travail à la perceuse pour métaux. (2 000 mots & fig.)

- 1924 669
Génie civil, n° 2191, 9 août, p. 131.
DURAND (J.). — Nouveau procédé de macrographie des métaux par impression directe sur pellicule. (2 200 mots & fig.)

- 1924 621 .331
Génie civil, n° 2193, 23 août, p. 165.
COLLIN (F.). — Le développement industriel des redresseurs de courant à vapeur de mercure. (5 700 mots & fig.)

- 1924 624 .63 (.73)
Génie civil, n° 2193, 23 août, p. 175.

- CAUFOURIER (P.). — Le renforcement au moyen de béton du pont métallique de Pulaski (Etats-Unis). (1 200 mots & fig.)

- 1924 62. (01 & 669 .1
Génie civil, n° 2193, 23 août, p. 178.
SEIGLE & CRETIN. — Limite élastique et résistance des aciers doux recuits dans le cas d'efforts combinés de traction et de torsion. (1 000 mots & fig.)

- 1924 621 .33 (.431)
Génie civil, n° 2193, 23 août, p. 180.
HOMOLATCH (E.). — L'électrification partielle de l'ancien métropolitain et des lignes de banlieue, à Berlin. (1 000 mots & fig.)

1924 62. (01 & 721 .1
Génie civil, n° 2198, 27 septembre, p. 278.

La résistance des pieux de fondation. (600 mots.)

1924 624 .2 (01
Génie civil, n° 2199, 4 octobre, p. 290.

PRUDON (G.). — Calcul des poutres à consoles et portiques raidis par des haubans. (1 600 mots & fig.)

1924 625 .244 (.44)
Génie civil, n° 2200, 11 octobre, p. 321.

Le développement des transports par wagons frigorifiques sur les réseaux français, pendant et depuis la guerre. (2 000 mots & fig.)

1924 62. (01 & 624. (01
Génie civil, n° 2200, 11 octobre, p. 323.

Limite admissible pour la charge de rouleaux en contact avec des chemins de fer de roulement plans. (1 300 mots & fig.)

1924 621 .132.6 (.436) & 621 .43 (.436)
Génie civil, n° 2200, 11 octobre, p. 325.

Locotracteur à moteur Diesel et à transmission hydraulique Lentz, des Ateliers de Gratz (Autriche). (500 mots & fig.)

La Science et la Vie. (Paris.)

1924 621 .2 (.44)
La Science et la Vie, septembre, p. 189.

REVELIN (L.). — L'établissement des usines hydro-électriques en France. (4 000 mots & fig.)

1924 621 .132.8 & 621 .335
La Science et la Vie, octobre, p. 347.

ANDRY-BOURGEOIS. — Un type de locomotive électrique à turbines à vapeur ou locomotive turbo-électrique. (2 800 mots & fig.)

Les chemins de fer et les tramways. (Paris.)

1924 625 .216
Les chemins de fer et les tramways, octobre, p. 132.

Attelage automatique des trains. (2 400 mots & fig.)

1924 625 .143.5
Les chemins de fer et les tramways, octobre, p. 135.

Attache du rail Vignole avec dispositif de nivellement semi-automatique des voies ferrées. (1 400 mots & fig.)

1924 656 .253
Les chemins de fer et les tramways, octobre, p. 140.

Prise de courant étanche pour l'éclairage électrique des signaux de chemins de fer. (1 000 mots & fig.)

L'Industrie des tramways, chemins de fer et transports publics automobiles. (Paris.)

1924 621 .33 (09.1 (.44) & 625 .62 (09.1 (.44)
L'Industrie des tramw. et ch. de fer, juin, p. 161.

Visite des réseaux de tramways de Strasbourg et de Nancy. (8 200 mots, tableaux & fig.)

1924 625 4 & 625
L'Industrie des tramw. et ch. de fer, juin, p. 180.

BOURREL (M.). — La documentation dans les transports en commun. (2 300 mots & fig.)

1924 621 .33 (.4
L'Industrie des tramw. et ch. de fer, juin, p. 184.

L'électrification des lignes de la banlieue Ouest Paris. (2 300 mots, 1 tableau & fig.)

1924 621 .3.
L'Industrie des tramw. et ch. de fer, juin, p. 190.

ALLIEAUME. — La protection des sous-stations traction. (1 800 mots & fig.)

1924 621 .133
L'Industrie des tramw. et ch. de fer, juin, p. 192.

Note sur la consommation de charbon des locomotives à vapeur. (3 500 mots & fig.)

1924 388 (.4
L'Industrie des tramw. et ch. de fer, août, p. 270.

DELAVERNE (G.). — Les transports en commun et l'urbanisme. Leur influence sur l'extension des villes et des régions qui les avoisinent. (6 700 mots & fig.)

1924 625 .617 (.44
L'Industrie des tramw. et ch. de fer, septembre, p. 33.

REGUÉ. — Essais d'automotrices à essence (type De Dion) sur le réseau des Chemins de fer Pau-Oloron-Mauléon. (3 600 mots & fig.)

1924 621 .133. (01 & 625 .61
L'Industrie des tramw. et ch. de fer, septembre, p. 33.

RENARD (Ch.) & VAN DEN BROEK. — Dispositif à adapter aux locomotives des chemins de fer d'intérêt local en vue de réaliser des économies de combustible surchauffe, économiseurs à vapeur, etc. (16 300 mots & fig.)

Revue générale des chemins de fer. (Paris.)

1924 341 .324 (.43
Revue générale des ch. de fer, août, p. 120.

SOULEZ (E.). — Note sur la régie des chemins de fer des territoires occupés. (10 500 mots, tableaux & fig.)

1924 625 .251
Revue générale des ch. de fer, août, p. 149.

Sabot-frein à commande automatique pour freinage des wagons dans les gares de triage. (2 400 mots & fig.)

1924 656 .254 (.44
Revue générale des ch. de fer, août, p. 167.

Situation du dispatching-system en France à la fin de 1923. (1 800 mots & fig.)

1924 656 .254 (.68
Revue générale des ch. de fer, août, p. 170.

Le contrôle du service des trains et de l'utilisation du matériel sur les chemins de fer sud-africains. (2 200 mots & fig.)

1924 385 .113 (.44)
Revue générale des ch. de fer, septembre, p. 203.
Résultats obtenus en 1923 sur les réseaux des cinq compagnies principales des chemins de fer français (Nord, Est, Orléans, Paris-Lyon-Méditerranée et Midi). (8 tableaux.)

1924 621 .132.7 (.44)
Revue générale des ch. de fer, septembre, p. 223.
Emploi de locotracteurs pour les manœuvres dans les gares moyennes du réseau P. L. M. (800 mots.)

1924 656 .221 (.44)
Revue générale des ch. de fer, septembre, p. 228.
Résistance de l'air sur les trains. (7 200 mots & fig.)

1924 625 .214 (.44)
Revue générale des ch. de fer, octobre, p. 255.
GRISON (A.). — Graissage du matériel roulant des réseaux français. (5 500 mots, tableaux & fig.)

1924 656 .229 (.44)
Revue générale des ch. de fer, octobre, p. 272.
PESCHAUD (M.). — La stratégie des transports et des ravitaillements. (7 900 mots & fig.)

Revue de l'Ingénieur. (Paris.)

1924 385. (07.11 (.73)
Revue de l'Ingénieur, juillet, p. 19.
FIRKET (G.). — L'organisation de l'enseignement technique supérieur aux États-Unis. (3 000 mots.)

Revue politique et parlementaire. (Paris.)

1924 385. (01 (.6)
Revue politique et parlementaire, 10 août, p. 243.
COMBESCURE (F.). — Le transsaharien nécessaire et suffisant. La voie de un mètre. (7 000 mots.)

1924 625 .13 (.42 + .44)
Revue politique et parlementaire, 10 septembre, p. 385.
Le tunnel et le chemin de fer sous la Manche. (6 600 mots.)

Revue universelle des mines, de la métallurgie, des travaux publics, des sciences et des arts appliqués à l'industrie. (Liège.)

1924 721 .3
Revue universelle des mines, 1^{er} août, p. 122.
LEMAIRE (L.). — Second mémoire sur le calcul des colonnes. (3 600 mots & fig.)

1924 625 .214. (01
Revue universelle des mines, 1^{er} août, p. 153.
PIESSEVAUX. — Note sur la valeur et l'utilisation des caractéristiques des huiles de graissage. (4 700 mots & 1 tableau.)

Revue universelle des transports. (Paris.)

1924 621 .133. (01
Revue universelle des transports, n° 10, 15 juillet, p. 146.
Locomotives à piston et locomotives à turbine. Application de la condensation. (2 600 mots.)

1924 388 (.493) & 656 .211 (.493)
Revue universelle des transports, n° 13, 1^{er} sept., p. 194.
Le problème des gares de Bruxelles. (5 000 mots & fig.)

1924 621 .132.3 (.44)
Revue universelle des transports, n° 14, 15 sept., p. 210.
Note sur les nouvelles locomotives « Superpacific » de la Compagnie du chemin de fer du Nord français. (900 mots, 1 tableau & fig.)

In German.

Archiv für Eisenbahnwesen. (Berlin.)

1924 385 .62 & 385 .63
Archiv für Eisenbahnwesen, Juli und August, S. 587.
FRITSCH. — Die neuen Entwürfe von Uebereinkommen über den internationalen Eisenbahnverkehr. (12 200 Wörter.)

1924 385. (09.1 (.51)
Archiv für Eisenbahnwesen, Juli und August, S. 620.
Die Eisenbahnen Chinas. (2 400 Wörter.)

1924 313 .385 (.43)
Archiv für Eisenbahnwesen, Juli und August, S. 636.
Die Deutsche Reichsbahn im Rechnungsjahr 1922. (Tabellen.)

1924 313 .385 (.494)
Archiv für Eisenbahnwesen, Juli und August, S. 661.
Die Schweizerischen Bundesbahnen im Jahr 1922. (250 Wörter & Tabellen.)

1924 313 .385 (.3)
Archiv für Eisenbahnwesen, Juli und August, S. 677.
Die Eisenbahnen der Erde im Jahr 1922. (400 Wörter & Tabellen.)

1924 313:656 .28 (.43 + .73)
Archiv für Eisenbahnwesen, Juli und August, S. 683.
Entgleisungen und Zusammenstöße und dabei vorgekommene Tötungen von Reisenden und Bediensteten in Deutschland und den Vereinigten Staaten von Amerika vom Jahr 1905 ab. (Tabelle & Abb.)

1924 625 .112 (.81)
Archiv für Eisenbahnwesen, September und Oct., S. 765.
BLOCH (E.). — Die Spurweiten der brasilianischen Eisenbahnen. (4 900 Wörter & 1 Karte.)

1924 313 .385 (.45)
Archiv für Eisenbahnwesen, Sept. und Oct., S. 814.
Die italienischen Staatseisenbahnen im Rechnungsjahr 1921-22. (5 300 Wörter & Tabellen.)

1924 313 .385 (.52)
Archiv für Eisenbahnwesen, Sept. und Oct., S. 837.
Die Eisenbahnen Japans im Rechnungsjahr 1922-23. (1 200 Wörter & 8 Tabellen.)

1924 313 .385 (.62)
Archiv für Eisenbahnwesen, Sept. und Oct., S. 846.
ROESNER (E.). — Die Eisenbahnen in Aegypten in den Rechnungsjahren 1917-18 - 1921-22. (800 Wörter & Tabellen.)

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1924 625 .232 (.43)
Glasers Annalen, Heft 1, 1. Juli, S. 1.
SPEER. — Gelenkpersonenwagen Bauart « Jakobs ». (4 800 Wörter & Abb.)

1924 621 .7 (.43)
Glasers Annalen, Heft 3, 1. August, S. 37.
BOEHME. — Zentrale Werkzeugmacherei eines Eisenbahn-Ausbesserungswerkes. (1 700 Wörter & Abb.)

1924 621 .132.7 (.43)
Glasers Annalen, Heft 3, 1. August, S. 41.
SCHULZ. — Ueber moderne Rangiermittel für Werkbahnen. (2 000 Wörter, Tabellen & Abb.)

1924 621 .132.5 (.497.1)
Glasers Annalen, Heft 4, 15. August, S. 51.
FRANKE (W.). — 1 D-Heissdampf-Güterzug-Lokomotiven für Serbien. (1 800 Wörter & Abb.)

1924 625 .246 (.43)
Glasers Annalen, Heft 5, 1. September, S. 67.
BIECK. — Ermittlung der in einem Selbstentladewagen mit Klappenverschluss wirkenden Kräfte. (1 000 Wörter & Abb.)

1924 625 .215 (.431)
Glasers Annalen, Heft 5, 1. September, S. 71.
Das Görlitzer Drehgestell. (500 Wörter & Abb.)

1924 625 .216 (.43)
Glasers Annalen, Heft 6, 15. September, S. 79.
METZKOW. — Aufgaben und Wirkungen des Eisenbahnpuffers unter besonderer Berücksichtigung der Reibungspuffer. (7 800 Wörter & Abb.)

1924 621 .33 (01)
Glasers Annalen, Heft 6, 15. September, S. 90.
SORGER. — Die Wirtschaftlichkeit der elektrischen Zugförderung in Abhängigkeit von der Unterhaltung der Lokomotiven und vom Bau und Betrieb grösserer Ausbesserungswerke für elektrische Lokomotiven. (9 000 Wörter & Abb.)

1924 621 .132.3 (.43) & 621 .132.5 (.43)
Glasers Annalen, Heft 6, 15. September, S. 99.
NORDMANN. — Lokomotiven für starke Steigungen. (8 300 Wörter, 5 Tabellen & Abb.)

1924 625 .213 (.43)
Glasers Annalen, Heft 6, 15. September, S. 114.
KREISSIG (E.). — Biegungs-, Zug- und Druckfedern in bezug auf Fahrzeugabfederung. (3 400 Wörter, 2 Tabellen & Abb.)

1924 625 .214 (.43)
Glasers Annalen, Heft 6, 15. September, S. 120.
SCHARFENBERG (K.). — Einheitsachsager der Deutschen Reichsbahn. (900 Wörter & Abb.)

1924 621 .
Glasers Annalen, Heft 6, 15. September, S. 130.
WERNER. — Wirtschaftliche Fertigung im Güterwagenbau. (2 000 Wörter & Abb.)

1924 621 .132.6 (.436) & 621 .43 (.436)
Glasers Annalen, Heft 6, 15. September, S. 148.
Probefahrten mit einer 60 PSe normalspurigen Graze Dieselmotor-Lokomotive mit hydraulischem Lentzgetriebe auf der Strecke Gleisdorf-Fehring der österreichischen Bundesbahnen. (2 500 Wörter & Abb.)

In English.

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(New York.)

1924 656 .253 (.73)
Amer. Ry. Ass^{on}, Signal Section, Advance notice, p. 5
Committee X. — Signaling practice. (25 000 words.)

1924 656 .25 (01) (.73)
Amer. Ry. Ass^{on}, Signal Section, Advance notice, p. 60
Committee V. — Instructions. (7 400 words & fig.)

1924 656 .257 (.73)
Amer. Ry. Ass^{on}, Signal Section, Advance notice, p. 78.
Committee II. — Mechanical interlocking. (5 900 words.)

1924 656 .256.3 (.73)
Amer. Ry. Ass^{on}, Signal Section, Advance notice, p. 92.
Committee VIII. — Alternating current automatic block signaling. (3 000 words & fig.)

1924 656 .251 (.73)
Amer. Ry. Ass^{on}, Signal Section, Advance notice, p. 101.
Committee VI. — Designs. (800 words & fig.)

1924 656 .256 (.73)
Am. Ry. Ass^{on}, Signal Section, Advance notice, p. SC. 22.
DAY (S. M.). — Alternating current track circuits. (8 400 words, 1 table & fig.)

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1924 625 .152 (.73) & 625 .162 (.73)
Bull. Amer. Ry. Eng. Ass^{on}, February, p. 61a.
Report of Committee IX. — Signs, fences and crossings. (17 200 words, 2 tables & fig.)

1924 313:625 (.73)
Bull. Amer. Ry. Eng. Ass^{on}, February, p. 675.
Report on Committee XI. — Records and accounts. (4 000 words & fig.)

1924 313:625 (.73) & 656 .2 (.73)
Bull. Amer. Ry. Eng. Assⁿ, February, p. 703.
Report of Committee XXI. — Economics of railway operation. (11 000 words, tables & fig.)

1924 385 .51 (.73) & 625 .17 (.73)
Bull. Amer. Ry. Eng. Assⁿ, February, p. 745.
Report of Committee XXII. — Economics of railway labor. (29 700 words, tables & fig.)

1924 625 .142.2 (.73) & 691 (.73)
Bull. Amer. Ry. Eng. Assⁿ, March, p. 845.
Report of Committee XVII. — Wood preservation. (15 600 words, tables & fig.)

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1924 621 .332 (.73)
Electric Railway Journal, No. 2, July 12, p. 53.
North Shore adopts catenary suspension. (1 000 words & fig.)

1924 625 .143.2 (.73)
Electric Railway Journal, No. 4, July 26, p. 123.
Mill treatment doubles the life of rail. (1 700 words, tables & fig.)

1924 725 .32 (.73)
Electric Railway Journal, No. 5, August 2, p. 153.
Indianapolis has largest electric railway freight terminal in world. (1 800 words & fig.)

1924 621 .331 (.73)
Electric Railway Journal, No. 5, August 2, p. 163.
How the Indianapolis & Cincinnati Line was rehabilitated. (3 200 words & fig.)

1924 621 .338 (.73)
Electric Railway Journal, No. 8, August 23, p. 269.
LINDALL (J.). — Reducing weight of Rapid Transit cars saves \$108,000 a year. (3 400 words & fig.)

1924 625 .252 (.73) & 625 .253 (.73)
Electric Railway Journal, No. 11, September 13, p. 383.
McWHIRTER (J. S.). — Getting full value from sand brakes on air-brake cars. (2 400 words, 2 tables & fig.)

1924 621 .335 (.68)
Electric Railway Journal, No. 11, September 13, p. 390.
3 000-volt locomotives for South African Railway. (1 200 words, 1 table & fig.)

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1924 625 .155 (.54)
Engineer, No. 3577, July 18, p. 85.
35-ton electric « surface » traverser. (700 words & fig.)

1924 621 .97 (.42)
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A remarkable drop hammer and its work. (800 words & fig.)

1924 621 .132.5 (.82) & 621 .133.1 (.82)
Engineer, No. 3578, July 25, p. 94.
Oil burning locomotive for the Buenos Aires Southern Railway. (600 words & fig.)

1924 625 .616 (.54)
Engineer, No. 3579, August 1, p. 139.
Narrow-gauge Mallet locomotives for Burma. (300 words & fig.)

1924 656 .211.7 (.66)
Engineer, No. 3581, August 15, p. 183.
Cradles for a train ferry service in Nigeria. (1 500 words & fig.)

1924 621 .33 (.42)
Engineer, No. 3582, August 22, p. 216.
The Hendon-Edgware extension of the London Electric Railways. (2 200 words & fig.)

1924 385. (09.3 (.42)
Engineer, No. 3584, September 5, p. 268.
The father of railways. (1 900 words.)

1924 621 .9 (06.4 (.42)
Engineer, No. 3585, September 12, Supplement, p. i.
British machine tools at the Olympia Exhibition. (16 400 words & fig.)

1924 621 .33 (.42)
Engineer, No. 3587, September 26, p. 356.
Electrification of British main line railways. (1 700 words.)

1924 621 .335 (.68)
Engineer, No. 3588, October 3, p. 370.
Electric locomotive for the South African Railways. (2 600 words & fig.)

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1924 621 .87 (.42)
Engineering, No. 3055, July 18, p. 104.
25-ton electric level-luffing crane. (400 words & fig.)

1924 621 .43
Engineering, No. 3055, July 18, p. 110.
NAGEL (A.). — The Diesel engine. (3 000 words & fig.)

1924 621 .33 (.4)
Engineering, No. 3056, July 25, p. 117.
Power for rail transport. (2 000 words.)

1924 624 .52 (.94)
Engineering, No. 3056, July 25, p. 129.
The competitive designs for the Sydney harbour bridge. (2 900 words & fig.)

1924 385. (06.4 (.42)
Engineering, No. 3057, August 1, p. 160.
British Empire Exhibition: Railway material. (5 200 words & fig.)

1924 621 .331 (.42)
Engineering, No. 3059, August 15, p. 227.
Automatic sub-station for the Hendon-Edgware extension Railway. (2 900 words & fig.)

1924 624 .63 (.73)
Engineering, No. 3060, August 22, p. 257.
WYNN (A. E.). — **An economical design for arch centres.** (3 000 words & fig.)

1924 621 .95 (.42)
Engineering, No. 3061, August 29, p. 297.
Boring and tenoning machines. (1 500 words & fig.)

1924 621 .331 (.42)
Engineering, No. 3062, September 5, p. 323.
The Peebles-Reyrolle automatic substation. (6 500 words & fig.)

1924 669 .1
Engineering, No. 3062, September 5, p. 351.
ATCHISON (L.) & WOODVINE (G. R.). — **The changes of volume of steels during heat treatment.** (6 500 words, 3 tables & fig.)

1924 669 .1
Engineering, No. 3063, September 12, p. 391.
ROSENHAIN (W.). — **The hardening of steel.** (4 800 words & fig.)

1924 625 .232 (.62)
Engineering, No. 3066, October 3, p. 475.
British Empire Exhibition : Railway material. (1 500 words & fig.)

1924 621 .132.8 (.42)
Engineering, No. 3066, October 3, p. 479.
British Empire Exhibition : The Reid-MacLeod geared steam turbine locomotive. (640 words & fig.)

Engineering News-Record. (New York.)

1924 625 .111 (.73)
Engineering News-Record, No. 2, July 10, p. 60.
Grade separation at Detroit, Grand Trunk Railway. (1 900 words & fig.)

1924 625 .13 (.73)
Engineering News-Record, No. 2, July 10, p. 63.
Steel viaduct built under traffic replaces old timber spans. (800 words & fig.)

1924 625 .111 (.73) & 625 .113 (.73)
Engineering News-Record, No. 3, July 17, p. 88.
Improving Cleveland-Pittsburgh line. — Pennsylvania R. R. (2 700 words & fig.)

1924 624 .52 (.71)
Engineering News-Record, No. 3, July 17, p. 94.
CHAPLEAU (J. P.) & GOODRICH (C. M.). — **Cantilevering a heavy bridge span in Northern Quebec.** (1 600 words & fig.)

1924 725 .35 (.7)
Engineering News-Record, No. 4, July 24, p. 138.
Cold-storage and terminal warehouse at Cincinnati. (3 500 words & fig.)

1924 624 .6 (.7)
Engineering News-Record, No. 4, July 24, p. 150.
HAYDEN (A. G.). — **A method of designing partially fixed arch bridges.** (700 words & fig.)

1924 625 .13 (.7)
Engineering News-Record, No. 5, July 31, p. 168.
Tunneling in volcanic formations on Pit river project. (3 500 words, 1 table & fig.)

1924 691 (.7)
Engineering News-Record, No. 6, August 7, p. 222.
HEWES (L. I.). — **Analysis of grading curve for concrete aggregates.** (4 700 words, 3 tables & fig.)

1924 656 .212 (.7)
Engineering News-Record, No. 6, August 7, p. 227.
Layout and design of large modern freight terminal. (2 600 words & fig.)

1924 656 .211.5 (.7)
Engineering News-Record, No. 8, August 21, p. 294.
Station designed for occasional crowds at Champaign. (1 600 words & fig.)

1924 624 .63 (.7)
Engineering News-Record, No. 9, August 28, p. 328.
LAURGAARD (O.). — **Unusual spandrel-braced arch bridge built at Portland.** (1 600 words, 1 table & fig.)

1924 625 .14 (.7)
Engineering News-Record, No. 9, August 28, p. 336.
Relations of track stresses to locomotive design. (1 500 words.)

1924 625 .143.1 (.42)
Engineering News-Record, No. 10, September 4, p. 37.
New British standard rail sections. (300 words, 1 table & fig.)

1924 621 .335 (.73)
Engineering News-Record, No. 10, September 4, p. 39.
Oil-electric locomotive built for switching service. (900 words & fig.)

1924 62. (01 & 624 .)
Engineering News-Record, No. 11, September 11, p. 42.
LAURSON (P. G.). — **Calculating deflections of beams by a simple method.** (1 500 words & fig.)

1924 656 .213 (.73)
Engineering News-Record, No. 12, September 18, p. 452.
Virginian Railway builds double car-dumper coal pier. (3 300 words & fig.)

1924 624 .63 (.44)
Engineering News-Record, No. 12, September 18, p. 462.
WHITNEY (C. S.). — **Long span concrete arch design in France.** (3 300 words, 1 table & fig.)

1924 624 .63 (.73)
Engineering News-Record, No. 13, September 25, p. 600.
MILLER (H. D.). — California begins construction
of Douglas memorial bridge. (1200 words & fig.)

1924 625 .143.4
Engineering News-Record, No. 14, October 2, p. 536.
Rail joint designs presenting new features. (2000
words & fig.)

Institution of Civil Engineers. (London.)

1924 62. (01 & 624 .2 (01
Instit. of Civil Eng., Selected engineering papers,
No. 10, p. 3.
LAMB (E. H.). — The principle of virtual velocities
and its application to the theory of elastic structures.
(1400 words & fig.)

1924 624 .1
Instit. of Civil Eng., Selected engineering papers,
No. 15, p. 3.
GYDE (C. J.). — Some bridge foundations of moderate
depth. (6200 words & fig.)

Journal of the Institute of Transport. (London.)

1924 656 .212.5 (.42), 656 .222.6 (.42) & 656 .223 (.42)
Journal of the Institute of Transport, July, p. 416.
GRIFFITHS (H. R.). — Freight train formations.
(4400 words, 9 tables & fig.)

Journal, Permanent Way Institution. (London.)

1924 625 .14 (01 (.42)
Journal, Perm. Way Inst., August, p. 197.
BOWLER (F. T.). — G. W. R. standard permanent
way practice. (9000 words & fig.)

1924 625 .143.5 (.42)
Journal, Perm. Way Inst., August, p. 238.
PATTERSON (R. O.). — The manufacture of railway
hairs. (3600 words & fig.)

1924 624 .7 (.42)
Journal, Perm. Way Inst., August, p. 278.
QUICK (F.). — A pre-cast re-inforced concrete rail-
way under-bridge. (3000 words & fig.)

Journal of the Western Society of Engineers. (Chicago.)

1924 621 .31 (.4)
Journal Western Society of Engineers, June, p. 247.
JAMIESON (B. G.). — Central station practice in
Europe. (6000 words & fig.)

1924 625 .162 (.73)
Journal Western Society of Engineers, August, p. 321.
FORD (R. H.). — Elimination of grade crossings.
(5000 words.)

Mechanical Engineering. (New York.)

1924 621 .335 (.7 + .8)
Mechanical Engineering, September, p. 523.
STORER (N. W.). — Recent developments in electric
locomotives. (4100 words, 1 table & fig.)

1924 621 .116. (01 (.73) & 621 .133.1 (01 (.73)
Mechanical Engineering, September, p. 558.
Test code for solid fuels. (3700 words & fig.)

1924 621 .335 (.73)
Mechanical Engineering, October, p. 608.
ARMSTRONG (A. H.). — The development of the
electric locomotive. (5400 words, 1 table & fig.)

Modern Transport. (London.)

1924 621 .132.5 (.54)
Modern transport, No. 279, July 19, p. 3.
Articulated-type locomotives for India. (1600 words
& fig.)

1924 621 .33 (.3)
Modern transport, No. 279, July 19, p. 5.
Railway electrification. World power conference.
(3800 words.)

1924 625 .232 (.42)
Modern transport, No. 280, July 26, p. 3.
New sleeping saloons for the London Midland and
Scottish Ry. (600 words & fig.)

1924 621 .331 (.42)
Modern transport, No. 283, August 16, p. 10.
Power for electric traction. (1300 words & fig.)

1924 621 .338 (.42)
Modern transport, No. 283, August 16, p. 13.
New coaches for District Railway. (700 words & fig.)

Proceedings, American Society of Civil Engineers. (New York.)

1924 624 .6 (01 & 721 .4 (01
Proceed. Amer. Soc. Civil Eng., August, p. 755.
JANNI (A. C.). — The design of a multiple-arch
system and permissible simplifications. (15000 words,
8 tables & fig.)

1924 385 .21 (.73)
Proceed. Amer. Soc. Civil Eng., August, p. 837.
BLACK (W. M.). — Waterway and railway equi-
valents. (9000 words & 2 tables.)

1924 624 .2 (01
Proceed. Amer. Soc. Civil Eng., September, p. 969.
ABO (C. V. von). — Secondary stresses in bridges.
(40000 words, 33 tables & fig.)

1924 691 & 721 .9
Proceed. Amer. Soc. Civil Eng., October, p. 1161.
Standard specifications for concrete and reinforced
concrete. (44000 words, tables & fig.)

Railway Age. (New York.)

1924	313:656 .28 (.73)
Railway Age, No. 1, July 5, p. 11.	
Accident investigations; July-December, 1923. (5 000 words.)	
1924	621 .132.5 (.73)
Railway Age, No. 1, July 5, p. 19.	
Reading Consolidation type locomotive. (800 words, 1 table & fig.)	
1924	621 .335 (.68)
Railway Age, No. 2, July 12, p. 53.	
Electric locomotives for South African Railway. (3 000 words & fig.)	
1924	621 .131.1 (.73)
Railway Age, No. 2, July 12, p. 57.	
RUSSELL (F. E.). — The extension of locomotive runs. (3 500 words & 1 table.)	
1924	625 .143.2 (.73)
Railway Age, No. 2, July 12, p. 63.	
GENNET (C. W.). — How the quality of rails can be improved. (2 400 words & fig.)	
1924	656 .237 (.73)
Railway Age, No. 3, July 19, p. 109.	
COUNTY (A. J.). — The new problems of the accounting officer. (4 500 words.)	
1924	625 .13 (.73)
Railway Age, No. 4, July 26, p. 145.	
LANG (P. G.). — B. & O. replaces bridges of historic interest. (1 500 words & fig.)	
1924	625 .13 (.73)
Railway Age, No. 5, August 2, p. 189.	
CLEMENTS (M. F.). — Concrete flumes solve tunnel drainage problem. (2 000 words & fig.)	
1924	656 .253 (.73)
Railway Age, No. 5, August 2, p. 191.	
McINERNEY (M. G.). — Winking signals facilitate yard switching. (400 words & fig.)	
1924	621 .132.8 (.73) & 621 .43 (.73)
Railway Age, No. 5, August 2, p. 195.	
OWER (J. C.). — Motor car service on heavy grade road. (1 400 words & fig.)	
1924	725 .33 (.73)
Railway Age, No. 6, August 9, p. 229.	
Using concrete mattresses for foundations. (2 000 words & fig.)	
1924	621 .331 (.73)
Railway Age, No. 6, August 9, p. 237.	
A model oil-burning railroad power plant. (2 800 words & fig.)	
1924	385 (.73) & 621 .14 (.73)
Railway Age, No. 7, August 16, p. 275.	
North Shore Line eliminates bus competition. (1 900 words & fig.)	

1924	385 .15 (.73)
Railway Age, No. 7, August 16, p. 279.	
HINES (W. D.). — Why employees should oppose nationalization. (2 900 words.)	
1924	625 .14 (01 (.73)
Railway Age, No. 7, August 16, p. 283.	
GILLILAN (P. M.). — Otheograph records locomotive characteristics. (2 200 words & fig.)	
1924	656 .237 (.73)
Railway Age, No. 7, August 16, p. 287.	
KNIGHT (L. L.). — Division disbursement accounting on S. A. L. (4 400 words & fig.)	
1924	625 .253 (.73)
Railway Age, No. 7, August 16, p. 296.	
I. C. C. reports on air brake investigation. (2 700 words.)	
1924	313 .385. (04 (.73)
Railway Age, No. 7, August 16, p. 299.	
Report shows improved railroad performance. (2 100 words, 3 tables & fig.)	
1924	621 .131.
Railway Age, No. 8, August 23, p. 327.	
STUMPF (J.). — A successful unafrow locomotive is built. (1 600 words & fig.)	
1924	621 .33 (.3)
Railway Age, No. 8, August 23, p. 333.	
Electrification progress and power supply. (4 400 words & fig.)	
1924	625 .142.2 (.73) & 691 (.73)
Railway Age, No. 9, August 30, p. 359.	
New treating plant employs modern methods. (2 000 words & fig.)	
1924	621 .139 (.73), 625 .18 (.73) & 625 .27 (.73)
Railway Age, No. 9, August 30, p. 363.	
ARMSTRONG (G. W.). — Cost accounting in the mechanical department. (3 900 words, tables & fig.)	
1924	621 .335 (.73) & 621 .43 (.73)
Railway Age, No. 9, August 30, p. 371.	
The gas-electric passenger car returns. (1 700 words & fig.)	
1924	625 .144.2
Railway Age, No. 10, September 6, p. 404.	
Canting of rails now favored by many roads. (3 600 words, 1 table & fig.)	
1924	621 .132.5 (.439)
Railway Age, No. 10, September 6, p. 407.	
Hungarian Mallet with Brotan type boiler. (1 500 words, 1 table & fig.)	
1924	656 .253 (.73)
Railway Age, No. 10, September 6, p. 413.	
The Union continuous train control system. (4 000 words & fig.)	

1924 385 .51 (.73)
 Railway Age, No. 11, September 13, p. 453.
 Practical method of securing co-operation. (3 600 words & fig.)

1924 625 .13 (.73)
 Railway Age, No. 11, September 13, p. 461.
 KATZ (S. H.) & MEITER (E. G.). — Atmospheric conditions in railroad tunnels. (2 200 words & fig.)

1924 625 .215 (.73)
 Railway Age, No. 12, September 20, p. 487.
 Improved co-ordinating six-wheel truck. (1 500 words & fig.)

1924 621 .33 (.460)
 Railway Age, No. 12, September 20, p. 509.
 The Spanish Northern Railway electrification. (3 000 words & fig.)

1924 625 .162 (.73)
 Railway Age, No. 12, September 20, p. 513.
 The protection of railroad grade crossings. (3 500 words.)

1924 621 .132.8 (.73) & 621 .43 (.73)
 Railway Age, No. 13, September 27, p. 535.
 BEAN (W. L.). — Design factors of the gasoline rail car. (3 300 words, 2 tables & fig.)

1924 621 .138.5 (.73) & 625 .26 (.73)
 Railway Age, No. 13, September 27, p. 543.
 BATTEY (P. L.). — A new method of analyzing hop requirements. (4 400 words.)

1924 621 .138.3 (.73)
 Railway Age, No. 13, September 27, p. 551.
 PACK (A. G.). — Locomotive maintenance. (2 400 words.)

1924 621 .133.1 (.73)
 Railway Age, No. 13, September 27, p. 555.
 How to improve oil burning on locomotives. (3 200 words.)

1924 621 .135.2 (.73)
 Railway Age, No. 13, September 27, p. 558.
 Lubrication and its effect on locomotive service. (3 400 words.)

Railway Engineer. (London.)

1924 624 .8 (.41)
 Railway Engineer, August, p. 265.
 Bascule bridge and viaduct at Coleraine. (2 200 words & fig.)

1924 656 .257
 Railway Engineer, August, p. 283.
 The double-wire working of points and signals. (1 800 words & fig.)

1924 621 .131.2 (.73)
 Railway Engineer, September, p. 306.
 POULTNEY (E. C.). — American three-cylinder locomotives. (1 600 words & fig.)

1924 656 .257 (.42)
 Railway Engineer, September, p. 309.
 Mechanical interlocking. (400 words & fig.)

1924 621 .132.7 (.42) & 621 .43 (.42)
 Railway Engineer, September, p. 316.
 Diesel locomotive tests on the London & North Eastern Railway. (1 500 words, tables & fig.)

1924 625 .151. (01)
 Railway Engineer, October, p. 339.
 WALKER (R. D.). — Standard formulæ for calculating point and crossing dimensions. (800 words, 1 table & fig.)

1924 621 .132.3 (.41) & 621 .132.4 (.41)
 Railway Engineer, October, p. 345.
 New mixed-traffic locomotives for the Great Southern & Western Railway, Ireland. (600 words & fig.)

1924 625 .4
 Railway Engineer, October, p. 359.
 Elevated railways. (4 200 words & fig.)

Railway Engineering & Maintenance. (Chicago.)

1924 625 .144.2 (.73)
 Railway Engineering & Maintenance, September, p. 349.
 MOORE (M.). — Is the canting of rails desirable? (8 700 words, 1 table & fig.)

Railway Gazette & Railway News. (London.)

1924 621 .132.6 (.42)
 Railway Gazette & News, No. 3, July 18, p. 83.
 Four-cylinder « Baltic » tank engine, London Midland & Scottish Railway. (700 words & fig.)

1924 625 .245 (.82) & 656 .222.6 (.82)
 Railway Gazette & News, No. 4, July 25, p. 115.
 Live stock traffic on Argentine Railways. (2 000 words & fig.)

1924 621 .132.5 (.52)
 Railway Gazette & News, No. 4, July 25, p. 120.
 New 2-8-2 type heavy goods engine, Imperial Japanese Railways. (400 words.)

1924 621 .335 (.45 + .485 + .481)
 Railway Gazette & News, No. 4, July 25, p. 121.
 Electric traction in Italy, in Sweden and in Norway. (3 000 words, 2 tables & fig.)

1924 621 .132.8 (.68)
 Railway Gazette & News, No. 5, August 1, p. 146.
 Rail motor-cars for the Rhodesian Railways. (800 words & fig.)

1924 621 .131.3 (.41)
 Railway Gazette & News, No. 5, August 1, p. 149.
 New 4-6-0 mixed-traffic locomotive, Great Southern & Western Railway, Ireland. (600 words & fig.)

1924 621 .132.7 (.42) & 621 .43 (.42)
 Railway Gazette & News, No. 6, August 8, p. 178.

Tests of a 60-H.P. Diesel locomotive on the London & North Eastern Railway. (1300 words, 1 table & fig.)

1924 625 .112 (.3)
 Railway Gazette & News, No. 6, August 8, p. 187.
 Gauges of world's railways. (2300 words & table.)

1924 621 .132.6 (.42)
 Railway Gazette & News, No. 7, August 15, p. 215.

New goods tank locomotives, London Midland & Scottish Railway. (250 words & fig.)

1924 621 .131.3 (.42)
 Railway Gazette & News, No. 7, August 15, p. 217.

Testing locomotives on the Great Western Railway. (900 words & fig.)

1924 624 .09.1 (.54)
 Railway Gazette & News, No. 7, August 15, p. 222.

Big bridges on Indian Railways. (1500 words & 1 table.)

1924 621 .33 (.42)
 Railway Gazette & News, No. 8, August 22, p. 244.

Hendon-Edgware extension, London Electric Railway. (3800 words & fig.)

1924 625 .232 (.42)
 Railway Gazette & News, No. 8, August 22, p. 251.

New rolling stock, L. M. S. R. (300 words & fig.)

1924 625 .242 (.42)
 Railway Gazette & News, No. 9, August 29, p. 280.

The Great Western Railway's 20-ton coal wagons. (1500 words & fig.)

1924 625 .154 (.54)
 Railway Gazette & News, No. 10, September 5, p. 310.

New 85-ft. diameter locomotive turntables for the Bombay, Baroda & Central India Railway Company. (400 words & fig.)

1924 625 .215 (.44)
 Railway Gazette & News, No. 10, September 5, p. 312.

Pressed-steel bogie trucks in France. (1000 words & fig.)

1924 621 .132.3 (.54) & 621 .132.5 (.54)
 Railway Gazette & News, No. 10, September 5, p. 314.

Baldwin locomotives for the Madras & Southern Mahratta Railway. (300 words & fig.)

1924 625 .231 (.66)
 Railway Gazette & News, No. 10, September 5, p. 318.

New inspection cars for the Sudan Government Railways. (600 words & fig.)

1924 625 .3 (.42)
 Railway Gazette & News, No. 12, September 19, p. 374.

Railway and other exhibits at the British Empire exhibition. Some interesting details respecting the « Never-Stop » railway and roadrails Limited. (1400 words & fig.)

1924 621 .132.5 (.75)
 Railway Gazette & News, No. 12, September 19, p. 37.

New Mallet locomotives for American railways. (1000 words & fig.)

1924 621 .132.8 (.54)
 Railway Gazette & News, No. 13, September 26, p. 40.

The latest Garratt locomotive development. (700 words & fig.)

1924 625 .232 (.42)
 Railway Gazette & News, No. 14, October 3, p. 439.

New rolling-stock for day East Coast trains, L. N. E. Ry. (3300 words & fig.)

1924 656 .257 (.42)
 Railway Gazette News, No. 15, October 10, p. 476.

Long-distance point operation. (1300 words & fig.)

Railway Magazine. (London.)

1924 656 .222.1 (.42)
 Railway Magazine, August, p. 111.

September, p. 199.

October, p. 265.

ALLEN (C. J.). — British locomotive practice and performance. (14000 words, 8 tables & fig.)

Railway Mechanical Engineer. (New York.)

1924 621 .134.3 (.436)
 Railway Mechanical Engineer, July, p. 407.

NIKILITCHEK (A.). — Development of the Lent Poppet valve gear. (1200 words & fig.)

1924 621 .133.
 Railway Mechanical Engineer, July, p. 409.

GANGEWERE (E. P.). — Analysis of feed water heating devices. (600 words.)

1924 625 .26 (.73)
 Railway Mechanical Engineer, July, p. 419.

McLENNAN (J.). — Unit system for freight car repairs. (1000 words & fig.)

1924 625 .231 (.73) & 625 .232 (.73)
 Railway Mechanical Engineer, July, p. 422.

New passenger equipment for the T. H. & B. (900 words & fig.)

1924 625 .253. (06 (.73)
 Railway Mechanical Engineer, July, p. 424.

Proceedings of the Air Brake Association. (5400 words & fig.)

1924 621 .39 (.73)
 Railway Mechanical Engineer, July, p. 430.

HEATON (J. S.). — Welding equipment in a rail road shop. (1600 words & fig.)

1924 621 .134.1 (.73) & 621 .138.5 (.73)
 Railway Mechanical Engineer, July, p. 437.

WESTBROOK (M. H.). — Handling rod work at Battle Creek shops. (2500 words & fig.)

1924 621 .139 (.73) & 625 .27 (.73)
 Railway Mechanical Engineer, August, p. 459.
 ARMSTRONG (G. A.). — Cost control for the
 mechanical department. (3 900 words & fig.)

1924 621 .131.1 (.73)
 Railway Mechanical Engineer, August, p. 464.
 RUSSELL (F. E.). — Extension of locomotive runs.
 (3 800 words & 1 table.)

1924 621 .133.1
 Railway Mechanical Engineer, August, p. 473.
 HATCH (M. C. M.). — Oil and coal as locomotive
 fuels. (600 words & fig.)

1924 51. (08 (.73) & 625 .212 (.73)
 Railway Mechanical Engineer, August, p. 481.
 WILLIAMS (M. H.). — Application of micrometers
 in railway shops. (4 100 words & fig.)

1924 725 .33
 Railway Mechanical Engineer, August, p. 486.
 WANAMAKER (E.). — Some questions in modern
 shop design. (2 600 words.)

1924 725 .33 (.73)
 Railway Mechanical Engineer, August, p. 491.
 Locomotive shops reconstructed on D. & R. G. W.
 (3 700 words & fig.)

1924 621 .94 (.73)
 Railway Mechanical Engineer, August, p. 503.
 Heavy duty lathe provided with a rapid power tra-
 verse screw. (2 200 words & fig.)

1924 621 .131.1
 Railway Mechanical Engineer, September, p. 523.
 ASAKURA (K.). — Locomotive resistance and
 tractive force. (2 000 words & fig.)

1924 621 .132.8 (.73) & 621 .43 (.73)
 Railway Mechanical Engineer, September, p. 534.
 Self-propelled passenger car on N. Y., N. H., & H.
 (1 700 words & fig.)

1924 625 .214
 Railway Mechanical Engineer, September, p. 538.
 SKEGSBERG (O.). — Intelligent oilers will prevent
 hot boxes. (2 000 words.)

1924 621 .135.2 (.73)
 Railway Mechanical Engineer, September, p. 540.
 HAHN (J. H.). — Handling driving box work. (2 500
 words.)

Railway Review. (Chicago.)

1924 625 .154 (.73)
 Railway Review, No. 26, June 28, p. 1241.
 New turntable installed in record time. (1 500 words
 & fig.)

1924 625 .143.2 (.73) & 669 .1 (.73)
 Railway Review, No. 26, June 28, p. 1245.
 ALLEN (C. J.). — The sorbitic treatment of rails.
 2 100 words & fig.)

1924 691 (.73)
 Railway Review, No. 26, June 28, p. 1252.
 Burlington operates four concrete products plants.
 (1 600 words & fig.)

1924 651 (.73)
 Railway Review, No. 1, July 5, p. 1.
 Labor-saving appliances in accounting work. (4 300
 words & fig.)

1924 656 .211.4 (.73)
 Railway Review, No. 1, July 5, p. 7.
 Improvement of efficiency on terminals. (6 400
 words.)

1924 621 .135.2 (.73) & 621 .138.5 (.73)
 Railway Review, No. 1, July 5, p. 15.
 GAINES (E. C.). — Driving box work, N. & W. Ry.
 shops, Roanoke, Va. (1 600 words & fig.)

1924 621 .133.1 (.73)
 Railway Review, No. 1, July 5, p. 24.
 McFARLANE (M.). — Preparing coal for locomotive
 fuel. (4 700 words.)

1924 621 .132.5 (.73)
 Railway Review, No. 2, July 12, p. 43.
 Reading Company Consolidation locomotives. (2 000
 words, 2 tables & fig.)

1924 625 .13 (.73) & 624 .03 (.73)
 Railway Review, No. 3, July 19, p. 77.
 Hill to hill bridge, Bethlehem, Pa. (3 700 words & fig.)

1924 625 .245 (.73)
 Railway Review, No. 3, July 19, p. 92.
 Interesting design of logging car. (1 400 words & fig.)

1924 656 .229 (.73)
 Railway Review, No. 4, July 26, p. 115.
 PENCE (A. W.). — Railway organizations of the
 United States Army. (5 000 words, 2 tables & por-
 traits.)

1924 621 .39 (.73)
 Railway Review, No. 4, July 26, p. 125.
 Report on autogenous and electric welding, presented
 before the annual convention of American Railway
 Association. (4 400 words & fig.)

1924 621 .139 (.73) & 625 .27 (.73)
 Railway Review, No. 5, August 2, p. 155.
 PEERY (J. E.). — Store delivery of material to users
 at shops. (3 000 words & fig.)

1924 621 .133.2 (.73)
 Railway Review, No. 5, August 2, p. 161.
 Four-sheet fireboxes for Mallet locomotives. (2 000
 words & fig.)

1924 625 .235 (.73) & 625 .246 (.73)
 Railway Review, No. 5, August 2, p. 166.
 Preparation of iron and steel surfaces for paint.
 (7 200 words & fig.)

- 1924 656 .253 (.73)
 Railway Review, No. 5, August 2, p. 177.
 Commission modifies train control order. (8 500 words.)
- 1924 621 .132.3 (.73)
 Railway Review, No. 6, August 9, p. 197.
 Chicago & Eastern Illinois Ry. 4-6-2 type locomotives. (1 900 words & fig.)
- 1924 624 .7 (.73)
 Railway Review, No. 6, August 9, p. 202.
 Long girder spans for reinforced concrete bridge. (1 500 words & fig.)
- 1924 656 .222 .1 (.73)
 Railway Review, No. 6, August 9, p. 205.
 Maximum train loads. (4 200 words.)
- 1924 385 .517 .6 (.73)
 Railway Review, No. 6, August 9, p. 208.
 Nurses' home, Houston Hospital, S. P. Co. (1 200 words & fig.)
- 1924 625 .113
 Railway Review, No. 7, August 16, p. 233.
 FELD (J.). — Clearance requirements on curved track. (1 700 words & fig.)
- 1924 625 .253 (.73)
 Railway Review, No. 7, August 16, p. 251.
 The Commission's report on power brakes. (10 100 words.)
- 1924 621 .7 (.73)
 Railway Review, No. 8, August 23, p. 271.
 A visit to a well organized railroad blacksmith shop. (4 200 words & fig.)
- 1924 625 .13 (.73)
 Railway Review, No. 8, August 23, p. 279.
 Jackson street subway, Camden terminal. (1 300 words & fig.)
- 1924 625 .156 (.73)
 Railway Review, No. 8, August 23, p. 283.
 Concrete bumping blocks on station tracks, Camden terminal, present pleasing appearance. (700 words & fig.)
- 1924 656 .235 .7 (.73)
 Railway Review, No. 8, August 23, p. 291.
 MARSHALL (J.). — Economic losses in transit of fresh fruits and vegetables. (3 400 words.)
- 1924 621 .132.8 (.73) & 621 .43 (.73)
 Railway Review, No. 9, August 30, p. 307.
 Gasoline motor coaches Missouri Pacific R. R. (2 800 words & fig.)
- 1924 621 .132.5 (.73)
 Railway Review, No. 9, August 30, p. 317.
 Mikado type locomotive, Elgin Joliet & Eastern Ry. (2 300 words, 1 table & fig.)
- 1924 625 .144.2 (.73)
 Railway Review, No. 9, August 30, p. 327.
 BURNS (J. J.). — Guard rails on sharp curves. (1 500 words & fig.)

- 1924 621 .335 (.73) & 621 .43 (.73)
 Railway Review, No. 10, September 6, p. 343.
 Distinctive features involved in new gas electric motor railcar. (1 800 words, 1 table & fig.)
- 1921 625 .13 (.73)
 Railway Review, No. 11, September 13, p. 383.
 Kensington-Delavan grade crossing elimination. (3 800 words & fig.)
- 1924 621 .132.7 (.73)
 Railway Review, No. 11, September 13, p. 393.
 Recent types of improved power for yard service. (3 700 words & fig.)
- 1924 625 .162 (.73)
 Railway Review, No. 11, September 13, p. 410.
 A new type of electrically operated high-way crossing gate. (600 words & fig.)
- 1924 656 .213 (.73)
 Railway Review, No. 12, September 20, p. 423.
 Some things which the Erie Railroad is doing. (5 000 words & fig.)
- 1924 385 .15 (.73) & 385 .3 (.73)
 Railway Review, No. 12, September 20, p. 431.
 DONNELLY (Ch.). — The American railroad problem. (3 700 words.)
- 1924 621 .33 (.460)
 Railway Review, No. 12, September 20, p. 434.
 TOTTER (A. L.) and HUTCHINSON (H. C.). — An interesting electrification project in Spain. (3 400 words & fig.)
- 1924 621 .132.3 (.73)
 Railway Review, No. 13, September 27, p. 457.
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IN
Vol. VI. — No. 12.

PUBLISHED EVERY MONTH.

December 1924.

Yearly prepaid subscription { Belgium, £ 1-16-0 = \$ 9
Foreign countries, £ 2 = \$ 10 } (including postage).

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OF THE
INTERNATIONAL RAILWAY CONGRESS
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(ENGLISH EDITION)
[385. (05)]



EDITORIAL OFFICES : Permanent Commission of the Association,
17, rue de Louvain, Brussels.

PUBLISHER : M. WEISSENBRUCH Co., Ltd., Printer to the King,
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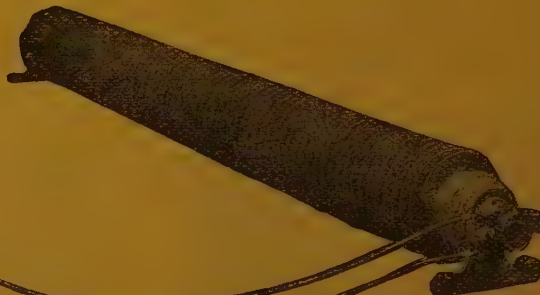
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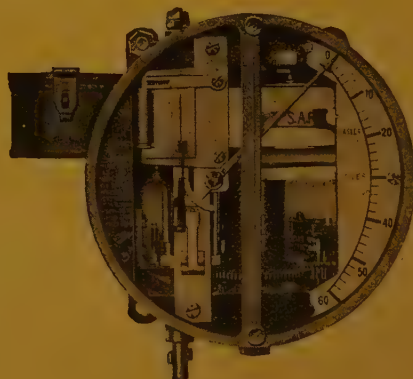
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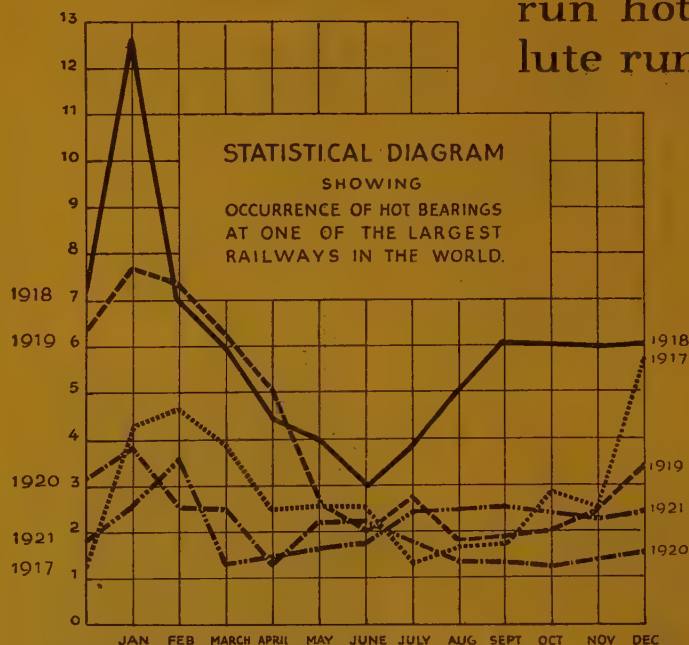
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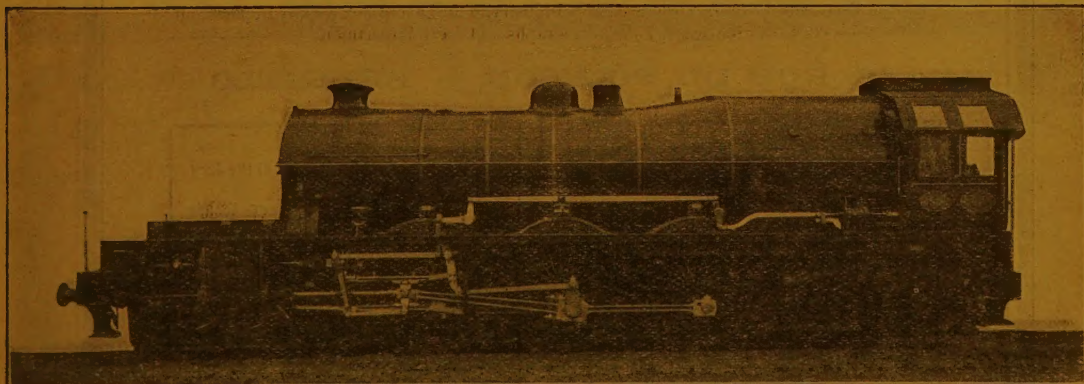
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